DOCUMENT RESUME

ED 101 932 SE 017 039

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|---|---|
| TITLE | Operation of Oil Burning Equipment and Incinerators. An Air Pollution Control Workbook, Preliminary Edition. |
| INSTITUTION | New Jersey State Dept. of Education, Trenton. Div. of Vocational Education.; New Jersey State Dept. of Environmental Protection, Trenton. Bureau of Air Pollution Control. |
| PUB DATE | [73] |
| NOTE | 135p. |
| EDRS PRICE | MF-$0.76 HC-$6.97 PLUS POSTAGE |
| DESCRIPTORS | *Air Pollution Control; Controlled Environment; Energy; Environmental Technicians; *Fuels; Industrial Technology; *Instructional Materials; Physical Environment; *Pollution; Public Health; State Legislation; Technology; *Waste Disposal |
| IDENTIFIERS | Incinerators |

ABSTRACT

This workbook has been prepared for use by persons charged with the burning of fuels and waste products in the State of New Jersey. It is written for building superintendents, custodians, porters, handymen and operating engineers of public, apartment, commercial and office buildings. The manual emphasizes operating procedures that will help meet air pollution regulations and prevent waste of fuel due to improper combustion. The text is based on a workbook initially published by the New York City Department of Air Pollution Control and the New York City Board of Education. The workbook contains six lessons entitled: Air Pollution and You; Fuel Oils, Burners, and Heaters; Oil Circulation Systems and Fuel Burning Equipment; Burner Controls; Maintenance; and Incinerators. Each individual lesson contains problems for further study and discussion. Selected portions of the New Jersey Air Pollution Control Laws and Codes supplement this workbook. (BT)

# OPERATION OF OIL BURNING EQUIPMENT AND INCINERATORS

## AN AIR POLLUTION CONTROL WORKBOOK




STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL

# OPERATION OF OIL BURNING EQUIPMENT

# AND INCINERATORS

An Air Pollution Control Workbook

Preliminary Edition

State of New Jersey
Department of Environmental Protection
Bureau of Air Pollution Control

P.O. Box 1390 Trenton, N.J. 08625

# PREFACE

This workbook has been prepared by the New Jersey Department of Environmental Protection, primarily for use by persons charged with the burning of fuels and waste products in the State of New Jersey. It is written for those who render invaluable service as building superintendents, custodians, porters, handymen, and operating engineers of public, apartment, commercial and office buildings.

The manual emphasizes good opera ing procedures which will help to meet air pollution regulations and prevent waste of fuel due to improper combustion. The text is based on a workbook initially published by the New York City Department of Air Pollution Control and the New York City Board of Education. The original material has been modified to reflect current air pollution control regulations and practices recommended in New Jersey.

The Department of Environmental Protection, in cooperation with the New Jersey Department of Education, Division of Vocational Education, presents this publication as a contribution to the continuing campaign for air pollution abatement and hopes its use will be profitable to all who study the material.

Richard J. Sullivan, Commissioner
New Jersey State Department of
Environmental Protection

William A. Munroe, Chief
Bureau of Air Pollution
Control

ACKNOWLEDGEMENT

The Bureau of Air Pollution Control of the New Jersey Department of Environmental Protection gratefully acknowledges the cooperation of the City of New York Environmental Protection Administration, Department of Air Resources, and the New York State Department of Health for their kind permission to freely adapt the material in their book, "Air Pollution Control, A Workbook for Operators of Residual Oil Burning Equipment and Incinerators."

# INTRODUCTION

This manual is designed as a guide for persons who operate, or supervise the operation of, refuse burning and oil burning equipment. It is intended to show how to eliminate the emission of smoke and other air contaminants by proper operation and maintenance. It makes no attempt to cover all types of equipment in detail, nor does it provide thorough coverage of the theory of operation. It is intended to supplement the instruction of combustion equipment operators, rather than to meet the requirements for licensing.

CONTENTS

# LESSON ONE

## AIR POLLUTION AND YOU

If you operate an incinerator or an oil burner, you have a great deal to do with the condition of the air your fellow citizens are breathing. The sulfur content of the fuel and your operating practices affect three of the major components of air pollution: sulfur dioxide, a heavy pungent gas which corrodes buildings and is highly irritating to human lungs; particulate matter, finely divided solids or liquids (other than water) that can become wind-borne or suspended in air, and which blacken cities and reduce visibility; and carbon monoxide, a colorless, odorless and very toxic gas whose deadly properties are well known.

In highly urbanized areas in New Jersey, nearly 50% of the sulfur dioxide and particulates come from burning fuel to heat residential, office and industrial buildings; another 5% of the particulates come from incineration. Federal estimates of total carbon monoxide emissions show that nearly 8% comes from solid waste disposal. As the emissions of sulfur dioxide, particulates and carbon monoxide can all be reduced to some degree by the correct operation and maintenance of residual oil burning equipment and incinerators, you have a very important part in helping to keep New Jersey's air clean.

### What Air Pollution Does to You

Air pollution not only blackens your windowsills, it also blackens your lungs. The small black particulates are also thought to carry gaseous chemicals into the lungs. Sulfur dioxide, for example, becomes embedded in the moist tissue with consequent irritation of the respiratory tract. This makes the lungs less able to fight infection and cope with respiratory diseases.

Air pollution also reduces visibility because of the scattering of light from the surfaces of airborne particles; food, forage and ornamental plants are harmed by injury to leaves, stunted growth, decreasing size and yield of fruits, destruction of flowers. In addition, dirty air damages metals, paints and fabrics.

If you live in a metropolitan area, your family is paying for more frequent cleaning, painting and replacement of clothing and property, higher medical bills, and higher retail prices because of the bad effects of polluted air. Whatever trouble you take to help clean the air in your neighborhood may put money back into your own and your neighbor's pockets.

## What New Jersey is Doing to Clean the Air

The New Jersey Department of Environmental Protection has designed a modern, scientific attack on the problem of air pollution. Enforcement of the Air Pollution Control Code has already brought about significant reductions in pollutant emissions to the atmosphere, and it is expected that air quality in the state will continue to improve. Parts of the Air Pollution Control Code provide for control of emissions from furnaces, incinerators, boilers and process operations, for limiting the sulfur content of fuels, and for strict control of all burning operations during air pollution emergencies. Control of emissions from both diesel-powered and gasoline-fueled motor vehicles is beginning. In accordance with the Federal Air Quality Act of 1967, standards for the quality of the air respecting sulfur dioxide, particulates, carbon monoxide, hydrocarbons, photochemical oxidants and nitrogen oxides have been set. Reaching these standards depends upon vigorous enforcement of all present and future chapters of the Air Pollution Control Code.

A 22-station air monitoring network has been set up to measure actual pollution levels throughout the state, and provide information to chart progress towards our air quality goals. Four "comprehensive" monitoring stations check levels of nine or more pollutants and several weather parameters; eighteen smaller stations are designed to monitor sulfur dioxide, carbon monoxide and particulates. All of the pollutant monitors telemeter data to central headquarters in Trenton on a continuous basis, 24 hours a day, 365 days a year. The air monitoring information is used as a guide for action during high pollution episodes, for studies of air quality, and for daily preparation of an air quality index.

## How Temperature Inversions Affect Air Pollution

The sun heats up the earth which in turn heats up the air near the ground. Since warm air is lighter in weight than cold air, it tends to rise. Under normal conditions, for every 1,000 feet of elevation above the earth, the temperature of the air drops 5.5° F.

Normally as the air rises and cools, it is carried away by the prevailing winds. At times, however, the air near the ground cannot rise because there are layers of warmer air above. This condition is called a temperature inversion. When this occurs, pollutants including sulfur dioxide, carbon monoxide and particulates are trapped below the inversion layer.

A temperature inversion is usually broken up when the air near the ground warms during the day. Then the air that

was trapped rises into the cooler atmosphere and pollutants are carried away. However, sometimes temperature inversions persist for periods of several days. Then we have a potential of high air pollution in the area affected. (Figure 1-1.)

Since we have no control over the weather that causes temperature inversions, we must either attempt to limit the emission of pollutants into the air or be plagued with periods of intense pollution that can cause much suffering and even the death of susceptible persons. High air pollution episodes such as the ten-day period in 1963 when an estimated 403 persons in New York City died from the effects of pollution, and the London smog of 1952 when 4,000 died, must be avoided.

Your Role During an Air Pollution Emergency

When an inversion condition over the state is predicted for at least 36 hours, the Bureau of Air Pollution Control determines if the criteria for one of the stages of an air pollution emergency have been met. The major factors in reaching this decision are the readings of the air monitoring network and consultation with agencies and officials in neighboring states. If the predetermined dangerous levels are reached, the Governor may declare the existence of an air pollution emergency and order corrective actions in accordance with previously prepared standby plans. (See Chapter 12 of the Air Pollution Control Code, in the Appendix of this book.)

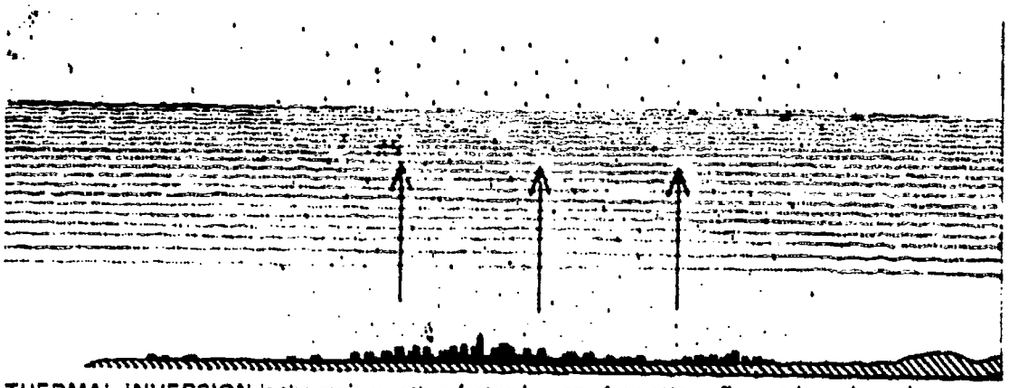
Three stages in an air pollution episode require action to reduce contaminants. These are: (1) alert (2) warning (3) emergency. At each successive stage, more stringent steps must be taken to bring about a rapid reduction in the amount of pollutants going into the atmosphere. If the levels keep rising and progressive stages are declared by the Governor, you as an operator of a boiler or incinerator will be expected to stop incineration and reduce heating levels in your building. Your rapid compliance can do a great deal to prevent a crisis. You may be notified by radio and television, or directly by a law enforcement or air pollution control official. You will be notified again when the weather conditions have changed and you can return to normal operation.

Failure to comply with the Governor's order to reduce contaminants, or with the directions of those authorized to enforce the Governor's order is a high misdemeanor, punishable by a severe fine or imprisonment. (See the Emergency Control Act, N.J.S.A., Title 26:2C-26 through 2C-36.)

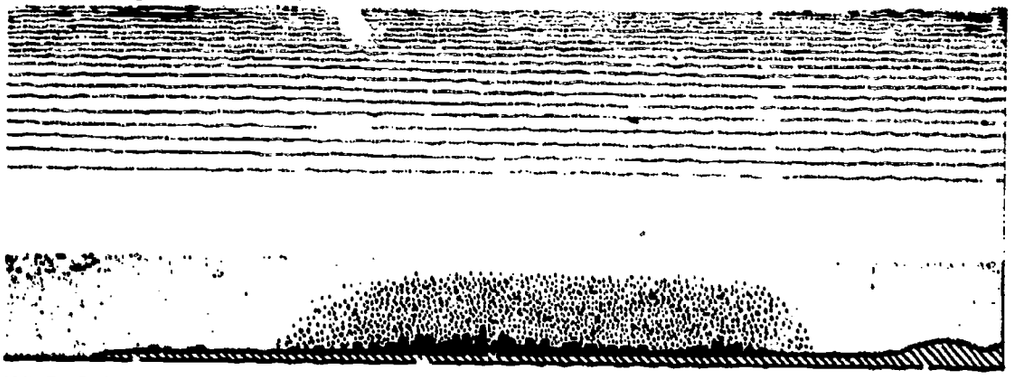
SELECTED REGULATIONS

Permits, Certificates, Licenses

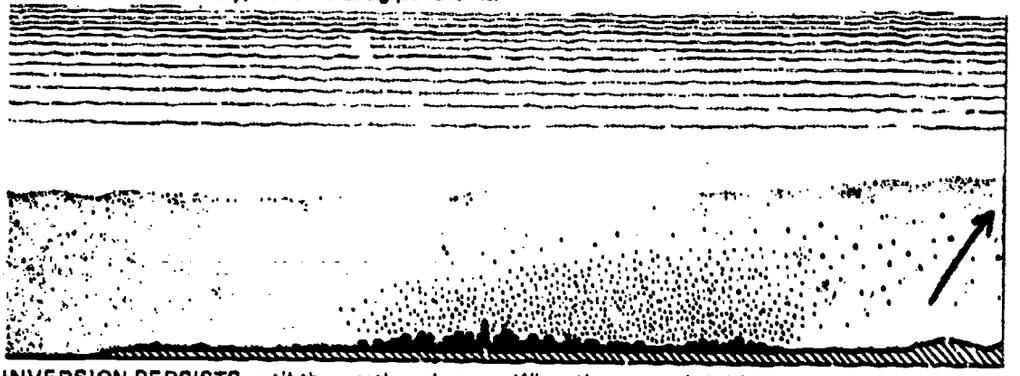
Owners and operators of residual fuel burning equipment



THERMAL INVERSION is the main weather factor in smog formation. Except in an inversion, air temperature decreases with height (darker tones indicate cooler air); the warm surface air rises, carrying pollutants away.



INVERSION SETS IN when cool air moves in under warm air and is trapped. The normal temperature gradient is reversed in the inversion layer, the base of which (at the surface in this drawing) forms a lid over the city, concentrating pollutants.



INVERSION PERSISTS until the weather changes. When the warm air is high enough to permit the cool air to escape, it will carry away the accumulated smog. Thermal inversions are common in many areas.

Figure 1-1

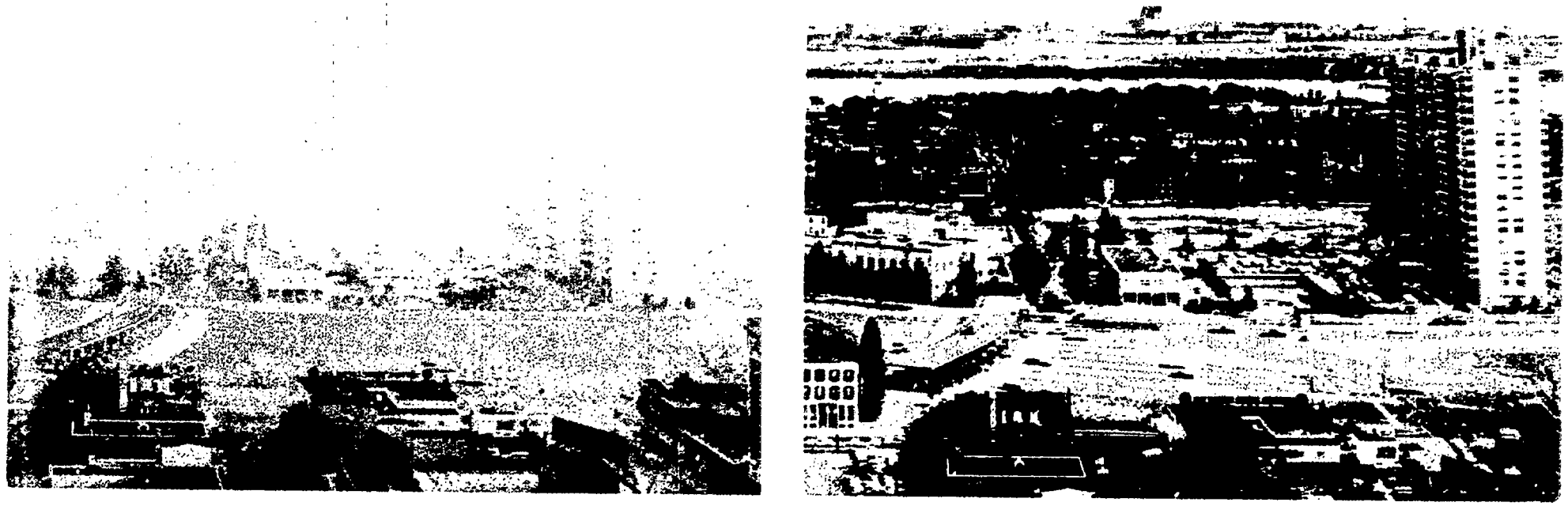


Figure 1-2. During a temperature inversion pollutants may build up, causing a reduction in visibility and other undesirable effects. These two views of Camden were taken from the same location, the left photo during a temperature inversion, the right photo on a clear day.

and incinerators must comply with the applicable provisions of the New Jersey Air Pollution Control Code, as well as with the requirements of the Mechanical Inspection Bureau, New Jersey Department of Labor and Industry, and with local building codes. Boiler registration and inspection certificates must be obtained and displayed as required; operating procedures and burning capacities for incinerators should be posted as near as possible to the point of operation; regulations governing installation, maintenance, repair and inspection of equipment should be available for ready reference.

Steam boilers, hot water boilers and pressure vessels must be inspected annually by the Mechanical Inspection Bureau, or by certified insurance inspectors. Licensed personnel is required for operation of steam boilers, steam generators, hot water heating or similar equipment potentially capable of generating steam, if the equipment exceeds six (6) boiler horsepower. (Horsepower is based on 34.5 pounds of water evaporated per hour from and at 212° F.) Information on the requirements of the Mechanical Inspection Bureau may be obtained from the Department of Labor and Industry, Post Office Box 1503, Trenton, New Jersey 08625.

Since June 15, 1967, the Bureau of Air Pollution Control, New Jersey Department of Environmental Protection, also requires persons to have a permit to construct, install or alter and a certificate to operate new or altered incinerators, as well as air pollution control apparatus and many types of equipment capable of emitting contaminants into the open air. See Chapter 9 of the New Jersey Air Pollution Control Code for information on equipment requiring a permit.

Emissions

In air pollution control, one important concern is with emissions into the atmosphere. Undesirable combustion products, such as particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides, unburned hydrocarbons and other gases are carried into the flue along with the products of complete combustion (carbon dioxide and water vapor).

Oil burners and incinerators give off smoke that varies from invisible to black. This smoke density can be compared to standard measurements on a Ringelmann Chart (Figure 1-3). Other testing methods may also be used by trained air pollution inspectors to check smoke emissions.

The regulations for control and prohibition of air pollution by smoke are given in Chapter 4 of the New Jersey Air

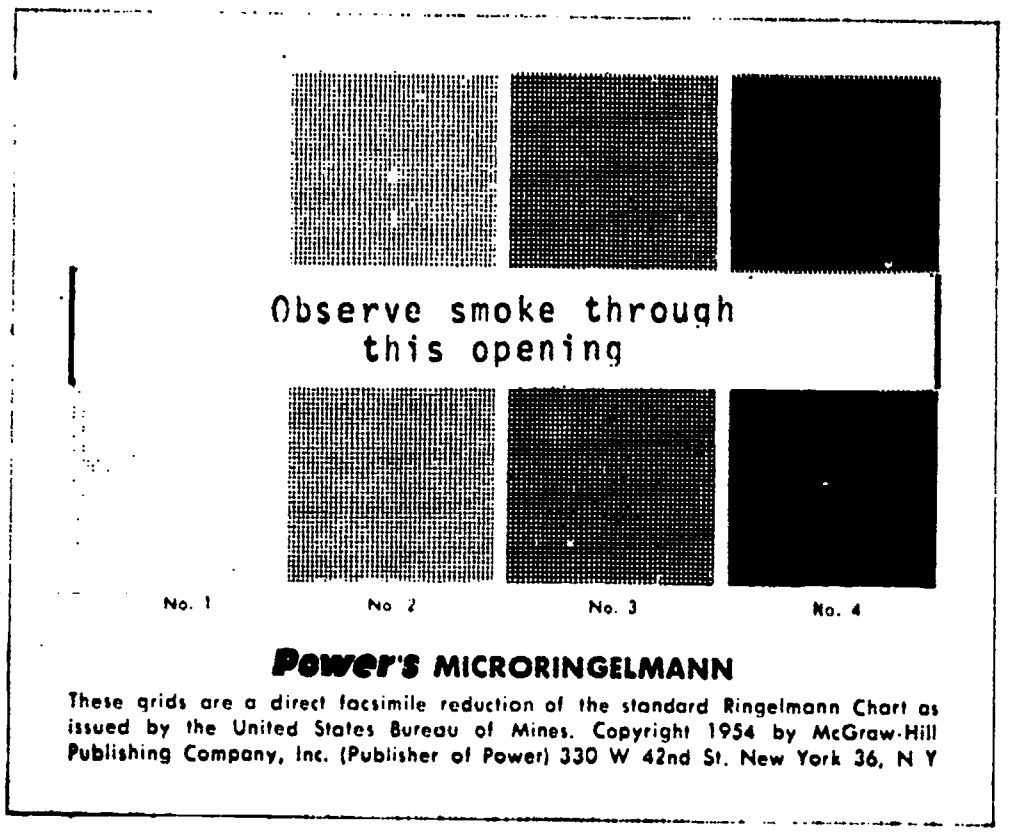



Figure 1-3

The Ringelmann Scale for Grading the Density of Smoke, published by the U. S. Bureau of Mines, has grids similar to the unofficial version shown here. Smoke is observed visually and matched with the corresponding grid to obtain the Ringelmann reading. The measurement of smoke density may be made by any chart, recorder, indicator or device which is approved by the Department of Environmental Protection as the equivalent of the Ringelmann Scale.

Pollution Control Code. (See Appendix of this book.) This code permits no visible smoke from combustion of fuel in any stationary indirect heat exchanger (such as a boiler) with rated hourly capacity of less than 200 million BTU gross heat input; from combustion of fuel in any stationary indirect heat exchanger with rated hourly capacity of 200 million BTU or greater (gross heat input) smoke may not be darker than Number 1 on the Ringelmann Smoke Chart (or 20% opacity, exclusive of water vapor). Darker smoke may not be visible for longer than three minutes in any consecutive 30-minute period.

This Chapter also gives standards for smoke emissions from marine installations, mobile sources, stationary internal combustion engines and stationary turbine engines.

Chapter 5 of the Air Pollution Control Code limits the emission of solid particles arising from the combustion of fuel in units where the heat input rate to the fuel burning equipment is 1 million BTU per hour or greater. Emission rates are limited on a graded scale providing for increased control as the unit size increases. Equipment covered by provisions of this Chapter requires a Permit to Construct, Install or Alter, and a Certificate to Operate, in accordance with Chapter 9 of the Code.

Chapter 11 of the New Jersey Air Pollution Control Code, which concerns incinerators, states

> "No person shall cause, suffer, allow or permit smoke from any incinerator the shade or appearance of which is darker than No. 1 of the Ringelmann Smoke Chart to be emitted into the open air..."

During the building of a new fire, the smoke from an incinerator may not be darker than No. 2 of the Ringelmann Smoke Chart for a period of three consecutive minutes. Chapter 11 also gives emission standards for particles, unburned waste and ash, and odors from incinerators, as well as the emission standards for smoke.

Incinerators may not be used unless all components connected, or attached to, or serving the incinerator, including control apparatus, are functioning properly and are in use, in accordance with the permit to construct, and the certificate to operate.

Complete copies of any chapter of the New Jersey Air Pollution Control Code may be obtained from the Bureau of Air Pollution Control, Department of Environmental Protection, John Fitch Plaza, P.O. Box 1390, Trenton, New Jersey 08625.

Sulfur Content in Fuel

The sulfur content of commercial fuel oil in New Jersey

has been restricted since May 1, 1968. No. 5, No. 6 and heavier fuel oils were limited to 1.0% sulfur by weight. Effective October 1, 1970, these fuels were limited to 0.5% sulfur, and effective October 1, 1971 to 0.3% sulfur. There are also limits on sulfur content of lighter grades of fuel oil. These provisions are included in Chapter 10 of the New Jersey Air Pollution Control Code, which also specifies maximum permissible emissions of sulfur dioxide from stacks or chimneys.

Other Regulations

Burning of rubbish in an incinerator may be restricted by local ordinances as well as by the provisions of Chapter 11. Local ordinances and building codes may also regulate location of boilers, storage of fuel oil, records to be kept, etc. Such regulations are adopted for the benefit of the entire community and careful compliance is a good citizen's responsibility.

REMEMBER THAT EFFICIENT OPERATION DEMANDS REGULAR INSPECTION, CLEANING AND REPAIRS OF THE BOILER AND INCINERATOR EQUIPMENT BY QUALIFIED MAINTENANCE PERSONNEL.

GLOSSARY OF AIR POLLUTION TERMS

Air Contaminant - Solid particles, liquid particles, vapors or gases which are discharged into the outdoor atmosphere.

Air Pollution - The presence in the outdoor atmosphere of one or more air contaminants in such quantities and duration as are, or tend to be, injurious to human health or welfare, animal or plant life or property, or would unreasonably interfere with the enjoyment of life or property throughout the State and in such territories of the State as shall be affected thereby and excludes all aspects of employer-employee relationship as to health and safety hazards.

Ambient Air Quality Standard - A limit on the concentration of a contaminant in the general outdoor atmosphere, which cannot be exceeded without causing or tending to cause injury to human health, welfare, animal or plant life or property, or unreasonably interfering with the enjoyment of life and property, excluding all aspects of employer-employee relationship as to health and safety hazards.

Carbon Dioxide - A colorless, odorless gas at standard conditions which has the molecular formula $CO_2$.

Carbon Monoxide - A colorless, odorless very toxic gas with the molecular formula CO, that burns to carbon dioxide with a blue flame and is formed as a product of the incomplete combustion of carbon.

Control Apparatus - Any device which prevents or controls the emission of any air contaminant.

Direct Heat Exchanger - Equipment in which heat from the combustion of fuel is transferred to a substance being heated so that the latter is contacted by the products of combustion and may contribute to the total effluent.

Equipment - Any device capable of causing the emission of an air contaminant into the open air, and any stack, chimney, conduit, flue, duct, vent or similar device connected or attached to, or serving the equipment. This shall include equipment in which the preponderance of the air contaminants emitted is caused by the manufacturing process.

Fly Ash - Particles of gas-borne solid matter arising from the combustion of solid fuel.

Fuel - Solid, liquid or gaseous materials used to produce useful heat by burning.

Fuel Burning Equipment - Any furnace, marine installation, internal combustion engine, boiler, apparatus, device, mechanism, stack or structure used in the process of burning fuel.

Fuel Oil - A liquid or liquefiable petroleum product burned for lighting or for the generation of heat or power and derived directly or indirectly from crude oil.

Fume - Solid particles generated by condensation from the vapor state, generally after volatilization from molten metals, etc.

Gases - Formless fluids which, under standard conditions, occupy the space of enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature.

Incinerator - Any device, apparatus, equipment or structure used for destroying, reducing or salvaging by fire any material or substance including but not limited to refuse, rubbish, garbage, trade waste, debris or scrap or facilities for cremating human or animal remains.

Indirect Heat Exchanger - Equipment in which heat from the combustion of fuel is transferred by conduction through a heat-conducting material to a substance being heated, so that the latter is not contacted by, and adds nothing to, the products of combustion.

Liquid Particles - Particles which have volume but are not of rigid shape and which upon collection tend to coalesce and create uniform homogeneous films upon the surface of the collecting media.

Opacity - The property of a substance which renders it partially or wholly obstructive to the transmission of visible light expressed at the percentage to which the light is obstructed.

Open Burning - Any fire wherein the products of combustion are emitted into the open air, and are not directed thereto through a stack or chimney.

Particles - Any material, except uncombined water, which exists in a finely divided form as liquid particles or solid particles at standard conditions.

Residual Oils - Liquid or semi-liquid products obtained as residues from the distillation of petroleum; sold for heating purposes.

Ringelmann Smoke Chart - The Ringelmann's Scale for Grading the Density of Smoke as published by the U. S. Bureau of Mines or any chart, recorder, indicator or device which is approved by the department as the equivalent of said Ringelmann's Scale for the measurement of smoke density.

Smoke - Small gas-borne and air-borne particles arising from a process of combustion in sufficient number to be observable.

Solid Particles - Particles of rigid shape and definite volume.

Soot - A finely divided powder produced during the combustion of coal, wood, oil, or other fuels; essentially carbon.

Stack or Chimney - A flue, conduit or opening designed and constructed for the purpose of emitting air contaminants into the outdoor air.

Standard Conditions - Shall be 70° F and one atmosphere pressure (14.7 psia or 760 mm Hg).

Sulfur Dioxide - A colorless gas at standard conditions which has the molecular formula $SO_2$.

Total Suspended Particulate Matter - Any matter dispersed in the outdoor atmosphere, whether solid or liquid, in which the individual particles are larger than molecules but smaller in diameter than 500 microns.

Vapors - The gaseous form of substances which, under standard conditions, are in the solid or liquid state and which can be changed to these states by either increasing the pressure or decreasing the temperature.

Viscosity - The measure of a fluid's resistance to flow.

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

## AIR POLLUTION AND YOU

1. Two important pollutants which come from burning fuels are particulates and _____ _____.
2. The _____ _____ network measures pollution levels at 22 stations throughout the state.
3. The second stage of an air pollution episode requiring action to reduce contaminants is called the_____stage.
4. When the air near the ground cannot rise because layers of air above it are warmer, the condition is called a_____ _____.
5. Particles include any material, except_____ _____, which exists in a finely divided form at standard conditions.
6. Fly ash consists of_____carried away with combustion gases.
7. Permits, certificates and notices pertaining to combustion equipment must be obtained and_____as required.
8. The Ringelmann Smoke Chart is used to check_____ _____.
9. Residual oils are obtained as residues from the distillation of_____and are sold for_____ purposes.
10. The products of complete combustion are_____ _____ and_____ _____.

11. Smoke from an incinerator may not be denser than_____ on the Ringelmann Smoke Chart, except during the building of a new fire when it may not be denser than_____ on the Ringelmann Chart.

12. Some undesirable combustion products are_____, _____, _____, _____.

## LESSON TWO

## FUEL OILS, BURNERS, AND HEATERS

### FUEL OILS

#### Classification of Fuel Oils

Crude oil from the well is distilled into individual products such as gasoline, diesel fuel, lubricating oils, and heating fuels. We will only be concerned with the heating fuels. These are classified by numbers from 1 to 6.

#1 Oil is the lightest and easiest to burn, generally referred to as kerosene or range oil. Of all the oils used, it has the lowest sulfur content.

#2 Oil is a light distillate fuel oil and is usually used in home oil burners. It also has a low sulfur content.

#3 Oil is no longer made commercially.

#4 Oil is a commercial and industrial heating oil, and does not require heating to pump or burn. It contains varying amounts of sulfur.

#5 Oil is an industrial heating oil not commonly used in New Jersey. It may require heating to pump the oil from the tank to the burner, and to burn it.

#6 Oil is a residual fuel oil used in most large plants. The term residual oil means that the lighter fuels such as gasoline, kerosene, and number 2 oil have been taken out of the crude oil. The thick asphalt-like residue that is left is #6 oil. This oil must be preheated before it can be pumped from the tank, put through the burner, or burned. Number 6 oil is also known as "Bunker C" oil, particularly when used on ships. It usually has a high sulfur content (2 - 3%) but is available at less than 1%.

#### Combustion Requirements

Each fuel has its own requirements for proper combustion. But there are certain conditions which must always be met:

An air supply must provide enough oxygen; the air must enter at the right time and in a way that will bring the oxygen in close contact with the fuel; the fuel must be at the right temperature - hot enough to burn - when it reaches the point where combustion is desired.

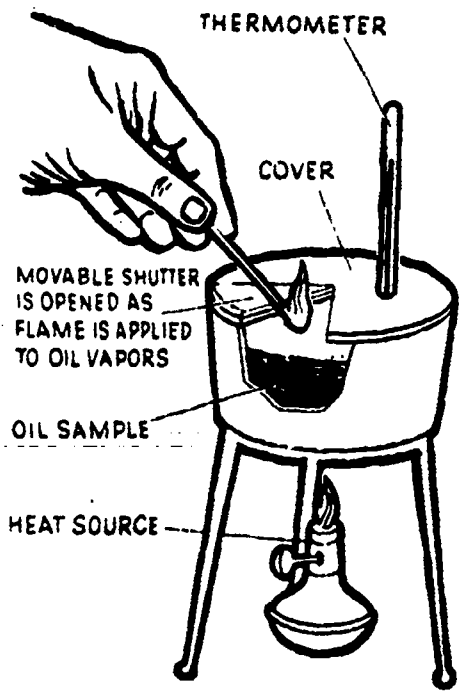
GLOSSARY OF FUEL OIL TERMS

To understand the use and burning of liquid fuel, it is necessary to know the meaning of some terms used in connection with fuel.

## Flash Point

Flash point is the coldest temperature at which oil wil flash into flame momentarily if a lighted match is passed just above the top of the oil. The flash point is considered in the safe storage of oil fuels. Oil in storage, if heated above the flash point, will begin to give off vapors that may flash into flame if a spark is created near-by. The average flash points of the main heating oils in New Jersey are:

| | | |
|---|---|---|
| #2 Oil | .. | 100° F |
| #4 Oil | .. | 130° F |
| #6 Oil | .. | 150° F |




MEASUREMENT OF FLASH POINT

Figure 2-1

## Fire Point

Fire point is approximately 10° above the flash point. Oil will continue to burn when a lighted match is passed over the top of the sample.

## Viscosity

Viscosity is a measurement of how easily an oil will flow. Low viscosity oils, like number 2, will flow easily. High viscosity oils, like number 6, will not flow unless the viscosity is reduced. Heat is applied to reduce the viscosity to a point where the oil will flow. This is why heaters are used in oil tanks, and in oil burner systems. A high viscosity oil which has not been heated will not pump, nor will it be atomized properly in the burner for good combustion.

One reason why viscosity is an important consideration in burning residual fuel is the frequent adjustments that are necessary to eliminate smoke. If the temperature or pressure of the oil changes, the air-oil ratio must be adjusted. This can be done by operating a key valve mounted in the magnetic oil valve, or by opening the air admission damper. Someone must make these adjustments or else automatic devices must be provided to do so. Where fully automatic burners are used, plant operators are not usually required to make adjustments. Various burner manufacturers have equipment which will automatically adjust for viscosity changes in the oil. These are called viscosity compensators.

## Pour Point

Pour point is a measure of the effect of temperature on the ability of fuel oils to flow. The pour point is measured by cooling oil until it just moves. Pour point and viscosity are not necessarily related. Oils from different oil fields may have widely varying pour points. For example, oils from one field with an asphalt base may have a pour point of about 30 - 40° F. However, oils from another field with a paraffin base may have a pour point of 60° F or higher. Pour point is important because if oil temperature falls below the pour point, it may not be possible to pump it. It is most important to keep oils with a paraffin base at temperatures above the pour point since the paraffin may set and block piping. In tanks, this setting of the oil may result in bridging. That is, a layer of oil in the mid section of the tank may set and the fluid oil beneath will be pumped out. The transfer pump would then lose suction.

## British Thermal Unit - BTU

The BTU rating of a fuel is an indication of how much heat it produces per pound. A BTU is the amount of heat necessary to raise the temperature of 1 pound of water, 1 degree Fahrenheit.

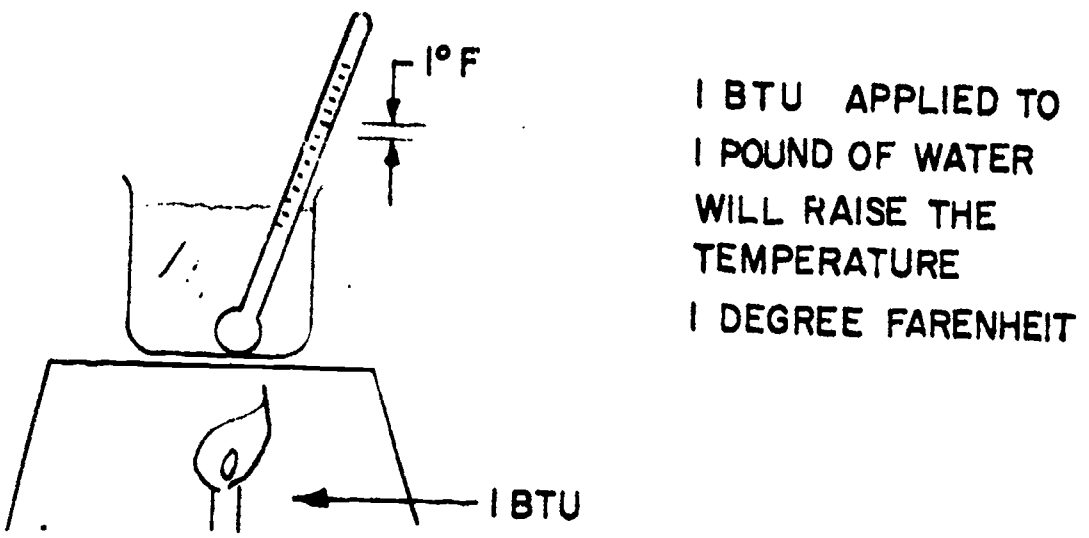



Figure 2-2

The BTU is used in all of the calculations to determine the type of oil used in the burner, the size of the boiler and burner, the size of the firebox, etc. The heavier oils contain more BTUs per gallon than the lighter oils. Number 6 oil averages more than 150,000 BTUs per gallon while Number 2 oil averages 136,000 BTUs per gallon.

## Specific Gravity

The specific gravity of fuel oil is important because it is a measure of fuel heating value. Specific gravity is a comparison of the weight of a given volume of oil (as for example a gallon) to the same volume of water, both at 60° F.

At 60° F, one gallon of a certain oil weighs 8.221 lbs.

At 60° F, one gallon of water weighs 8.337 lbs.

$$\frac{8.221}{8.337} = \underset{0.9861}{\text{Specific Gravity}}$$

Specific gravity of oils is generally converted to degrees A.P.I. (American Petroleum Institute). A.P.I. changes a long decimal to a short number. The following short table gives an example.

Specific Gravity at 60° F

| Degrees A.P.I. | Specific Gravity | Lbs. Per Gallon | BTU Per Pound | BTU Per Gallon |
|---|---|---|---|---|
| 5 | 1.0366 | 8.645 | 18,250 | 157,700 |
| 10 | 1.0000 | 8.337 | 18,450 | 154,000 |
| 15 | 0.9659 | 8.053 | 18,790 | 151,300 |
| 20 | 0.9340 | 7.787 | 19,020 | 148,100 |
| 25 | 0.9042 | 7.538 | 19,230 | 142,500 |
| 30 | 0.8762 | 7.305 | 19,420 | 141,800 |
| 35 | 0.8498 | 7.085 | 19,590 | 138,800 |
| 40 | 0.8251 | 6.879 | 19,750 | 135,800 |
| 45 | 0.8017 | 6.684 | 19,890 | 132,900 |
| 49 | 0.7839 | 6.536 | 20,000 | 130,700 |

NOTE: #6 oil usually ranges between 10 and 15 A.P.I.
#2 oil usually ranges between 25 and 35 A.P.I.

## Sulfur Content

The amount of sulfur in liquid fuels is now limited by law. (See Lesson One and Chapter 10 of the New Jersey Air Pollution Control Code.) The sulfur limits may sometimes be reached by blending different types of oils. Some paraffin base oils are practically sulfur free but have high pour points, whereas asphaltic oils have low pour points but a sulfur content above the legal limit. A blend of the two will reduce the objectionable features. Sulfur has little importance in the heating value of the oil but it does have serious effects once the oil is burned. The sulfur in the oil combines with the air during the burning process to become sulfur dioxide, a major pollutant. In addition, the oxides of sulfur from the oil remain in the soot and combine with moisture to form an acid which will corrode steel boiler parts and steel smoke stacks.

## Bottom Water and Sediment

Residual fuel contains approximately 2% of bottom water and sediment. The resulting sludge and water settles to the bottom of the tank and can cause difficulties if routine care in operation is not followed.

Usually, fuel oil tanks are designed to have the fill line extend to within 6" of the bottom. Dropping a load of oil stirs up the bottom. When the water and sludge are in suspension, the suction pump constantly removes a small amount

of sludge. The pump strainers trap the solid particles while the water passes on to the burner. The oil in the tank should be kept at a temperature suitable for transfer, about 120° F. When the tank becomes overheated, sludge and water settle out of the oil at a greater rate. Most tanks have suction bells that keep the oil heated around the suction and return lines (Figure 2 - 5). This restricts heating to a small section of the tank thus preventing additional settling of the sludge particles.

## BURNER TYPES

There are several types of oil burners in common use in New Jersey. A brief description of each is listed.

### Domestic or Gun Type Burner

The domestic or gun type oil burner is used with number 2 oil. Its operation is simple. The oil is pulled from the tank through a quick closing valve near the burner. This valve has a link that holds it open under normal conditions. But the link melts if a fire is near it; then the valve closes and shuts off the oil flow from the tank.

The oil passes through a strainer, through the pump on the end of the motor shaft, through the cut-off valve, the oil line then the oil nozzle into the furnace. When the thermostat or pressure control calls for heat, the electric circuits are closed. These cause the electrodes near the burner tip to spark, and also start the motor running. The pump on the motor shaft builds up an oil pressure of about 100 pounds which then opens the cut-off valve/pressure regulator, and puts oil through the nozzle. The air and oil mix at the burner tip, and are ignited by the electrodes. The spiral vanes provide motion to the air to thoroughly mix it with the oil mist. The air supply is regulated by the register on the air intake of the fan. This register has a tendency to change position due to vibration, if not properly secured, and may either close or open causing smoke or waste.

### Rotary Cup Burner

The rotary cup burner is most commonly used for #4, #5, and #6 oil. There are a variety of designs and refinements in equipment. The basic principle is that oil is pumped into a spinning cup under pressure. The oil is broken up into fine drops as it spins off the edge of the cup. At this point it is mixed with air, and ignited by a gas flame. This type of burner may be made fully automatic.

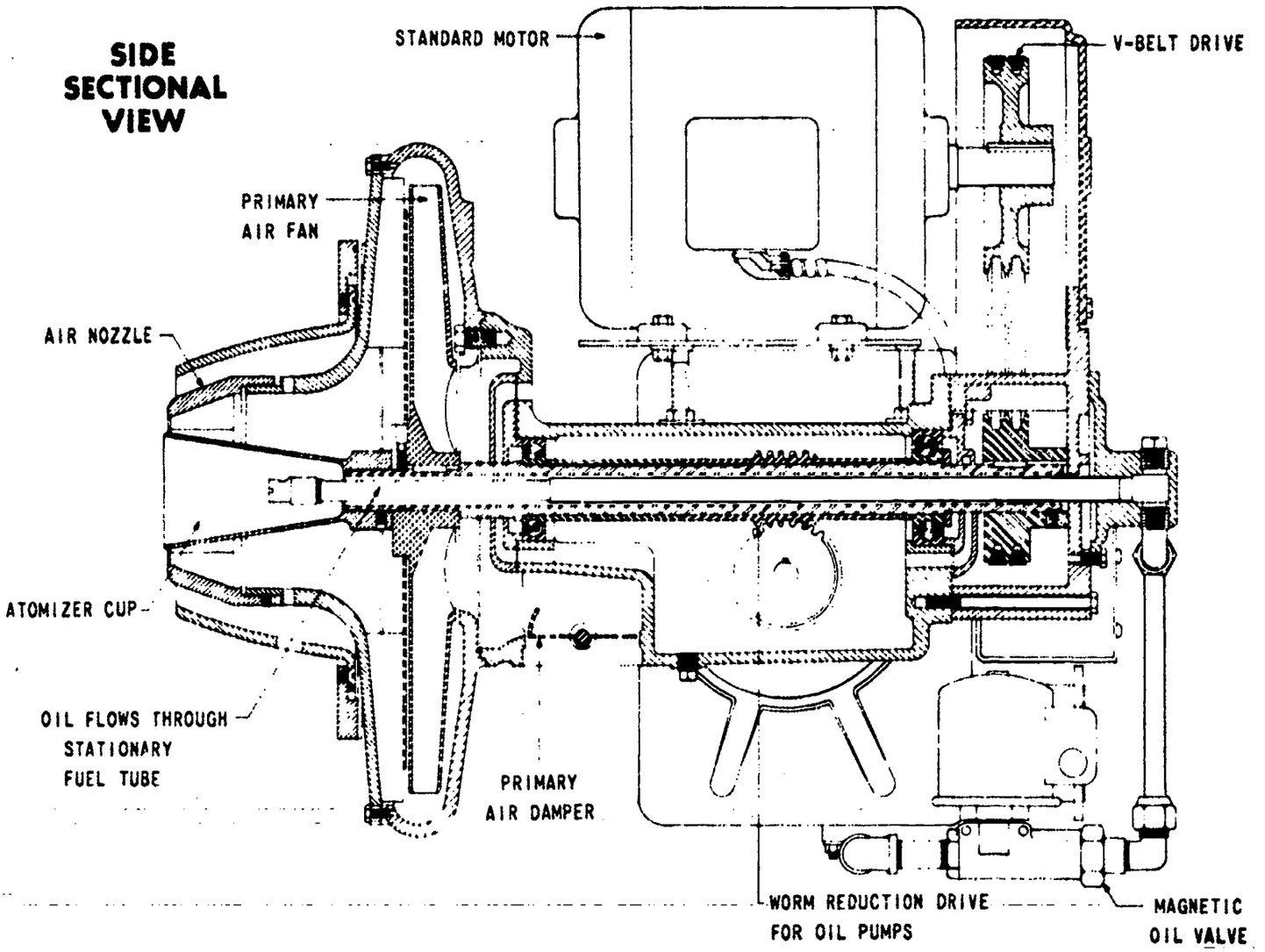
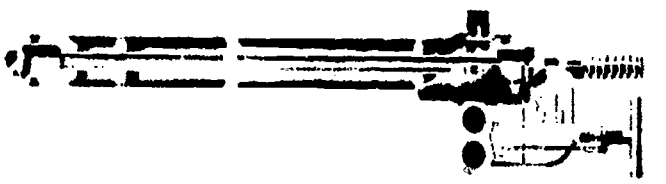



Figure 2-3. Rotary cup burner.



Straight Mechanical Oil Atomizer with rigid tubes for stationary nozzles.

Mechanical atomizing oil burners depend for atomization on the energy in the oil by virtue of its pressure, that is, the conversion of this energy to velocity. The oil flows thru tangential passages in the burner tip and emerges thru a central hole with sufficient rotative velocity to cause atomization, minute droplets flying off from the tip circumferentially. The required oil viscosity, about 150 SSU maximum, necessitates heating the heavier oils.

Firing rate of all burners is controlled by varying oil pressure; for a given system resistance, the pressure variation is as the square of the rating. The atomizing effect of steam and rotary cup burners is not dependent on oil pressure drop thru a nozzle, hence these burners function satisfactorily over a wide load range. This is not true of straight mechanical atomizing burners since energy for atomization depends on pressure, about 100 psig minimum. Unless the system is designed for very high pressure at maximum load, atomization is poor and burners drool or throw large droplets of oil at low load. While this can be accommodated by changing tips it necessitates taking burners out of service successively which temporarily upsets air distribution.

Air or Steam Oil Atomizer with flexible tubes for adjustable nozzles.

In steam atomizing burners streams of oil and steam impinge in a mixing chamber where the energy in the steam heats and atomizes the oil, and the mixture then enters the furnace. Oil viscosity need be only low enough to permit pumping, about 200 SSU.

Figure 2-4. Atomizing oil burners.

## Low-Pressure Air Atomizer Burner

The low-pressure air atomizing burner uses a large orifice and atomizes oil by air pressure inside the burner nozzle. This burner can replace a rotary cup burner.

## Steam-Air Atomizer Burners

On large boiler plants (usually above 150 gallons per hour) either steam or air is used to break up the oil so that it can be burned. Oil is pumped through a sprayer plate and mixed with either steam or air at pressures of about 100 pounds. This breaks the oil into a fine mist for burning. This type burner is manually started and stopped. The combustion may be controlled automatically.

Mechanical Pressure Burner

In the mechanical pressure type burner, the oil is pumped to an orifice plate through which it is discharged as a fine cone-shaped spray. The oil is mixed with air as it is discharged from the orifice. Starting and stopping the burner is a manual operation. The combustion control may be automatic.

FUEL OIL STORAGE

Permitting the oil in a tank to become cold can create smoke problems. When oil is chilled, it becomes difficult to pump and burn. This may cause a pulsating fire and smoke. Another cause of pulsating fire and smoke is water in the tank. Water may enter through the fuel fill pipe or the sounding wells during a rain storm. Other sources of water in a fuel tank are leaky hot water or steam heaters. The returns from heaters should be watched for signs of oil since this would indicate a leaky heater coil. Fuel fill pipe and sounding well plugs should be checked regularly for tightness.

If there is any indication of water in your fuel, notify your fuel supplier or your burner serviceman. He usually can test the tank for water and sludge, and has the equipment necessary to remove it.



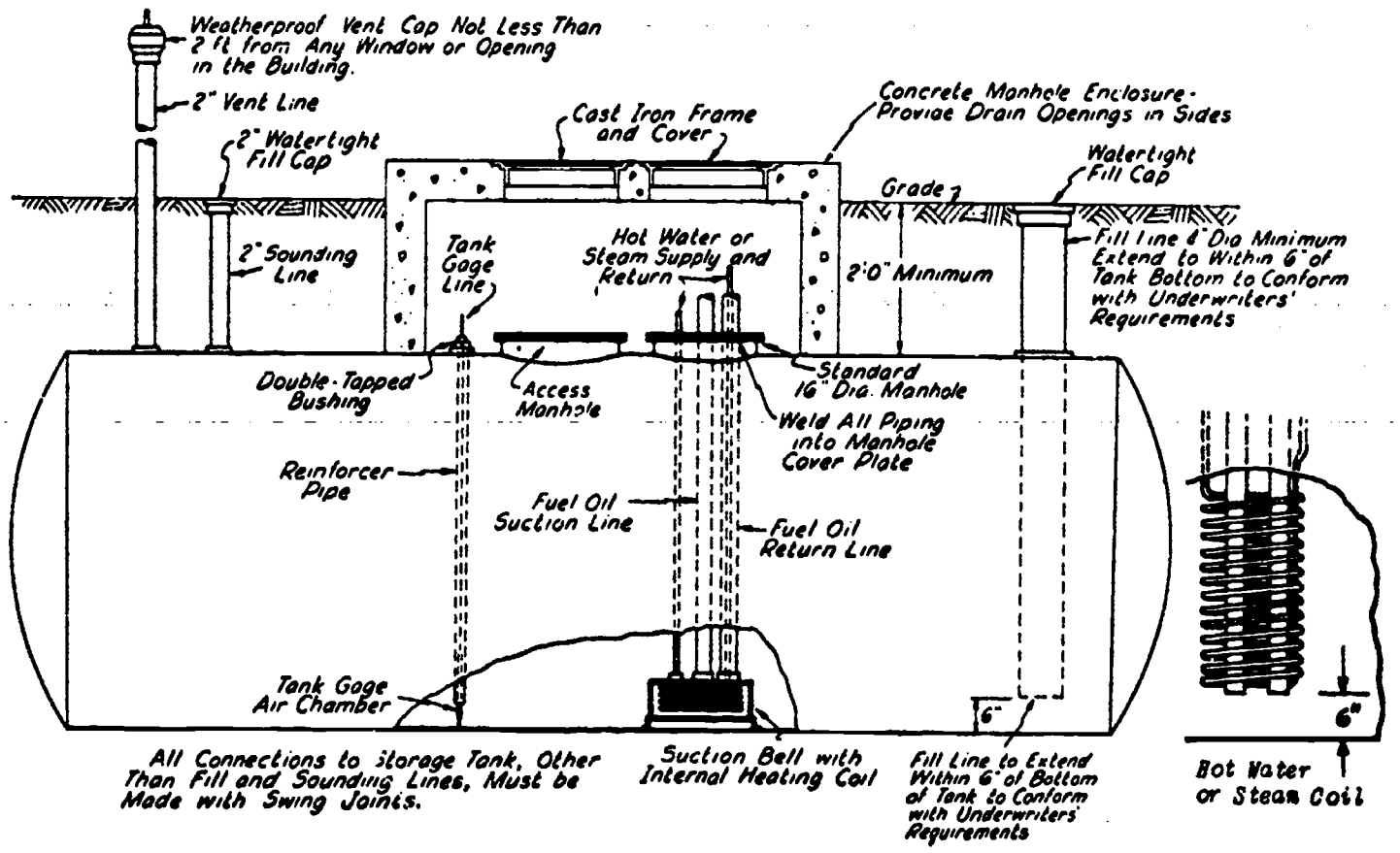



Figure 2-5. Fuel oil storage tank with suction bell.

FUEL OIL HEATERS

Fuel oil heaters are of great importance in preventing air pollution since smoke is frequently caused by cold oil. Cold oil not only causes smoke, but soot which the operator must remove. Smoke caused by unburned carbon or oil is also a waste of fuel.

In most tanks holding number 6 oil, only a small section around the suction and return piping is heated. This saves heat and reduces the amount of water settled out of the oil into the bottom of the tank. In the coil type heater, a steam or approved hot water coil forms a well into which the suction and return lines are extended. Steam or hot water is put through the coil for heat.

In the grid type tank heater, a flat heating unit is substituted for the coil, and is located under the ends of the suction pipes. Sometimes an electric stub heater is used instead of a steam coil. This reduces the chance of water in the oil, and provides heat in the tank when the boiler is not in use. Oil from the tank should be 120° F.

In general, there are two oil pre-heaters on a number 6 oil burner between the tank and the oil nozzle or cup:

1) The heater close to the burner warms the fuel oil in the line near the burner for starting. This is usually an electric heater equipped with an oil temperature control and a cold oil interlock. It will not permit the burner to start until the oil is hot enough to burn properly without smoke. The control terminals on this heater must not be "jumped" to permit start up on cold oil. The oil to the cup should be 180° F or higher. The best temperature for burning may be different with each shipment of oil, thus requiring careful adjustment.

2) Larger heaters in the fuel line provide heated oil for regular operation. These heaters may be electric, steam, or hot water.



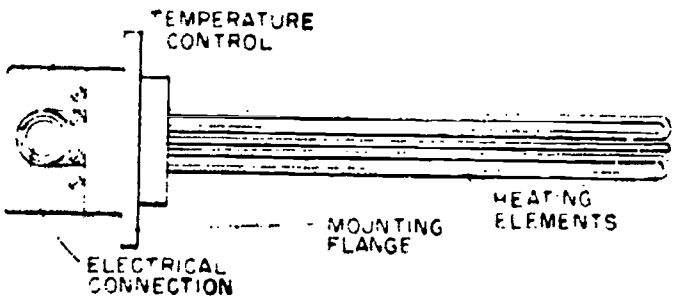



Figure 2-6. Electric fuel oil heater.

a) Electric heaters are similar to the heater near the burner. When installed, these heaters must be kept in operation. A regular check must be kept to see that the oil is heated to the proper temperature. If the temperature control fails to operate, it should be repaired or replaced. A faulty control may permit cold oil to reach the burner, causing smoke. A control that is turned up too high or "jumped" can cause overheating of

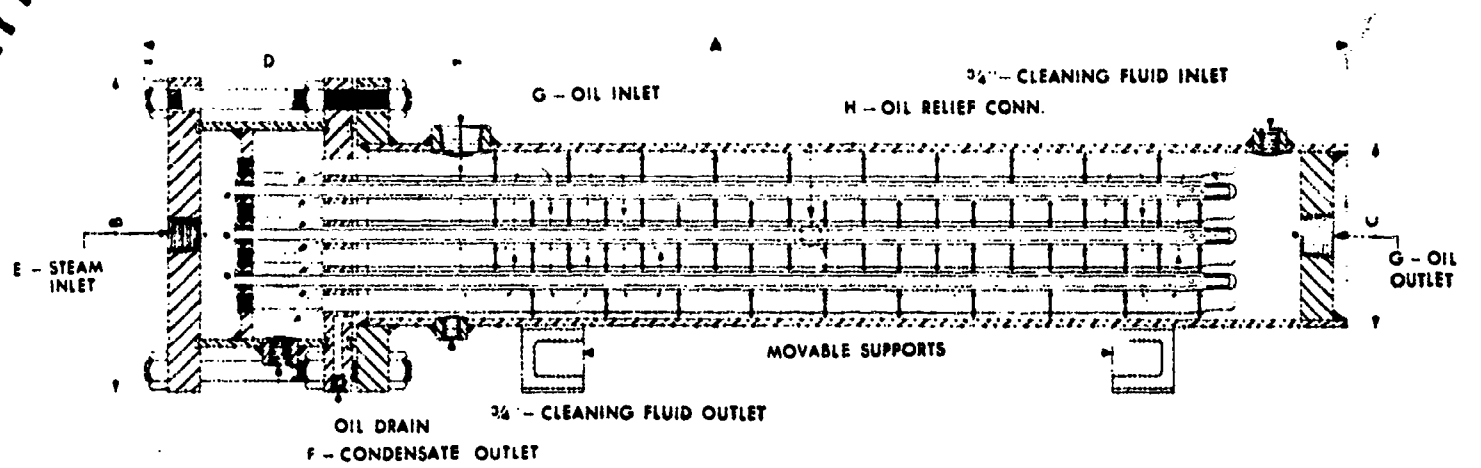



Figure 2-7. Shell and tube type steam fuel oil heater.

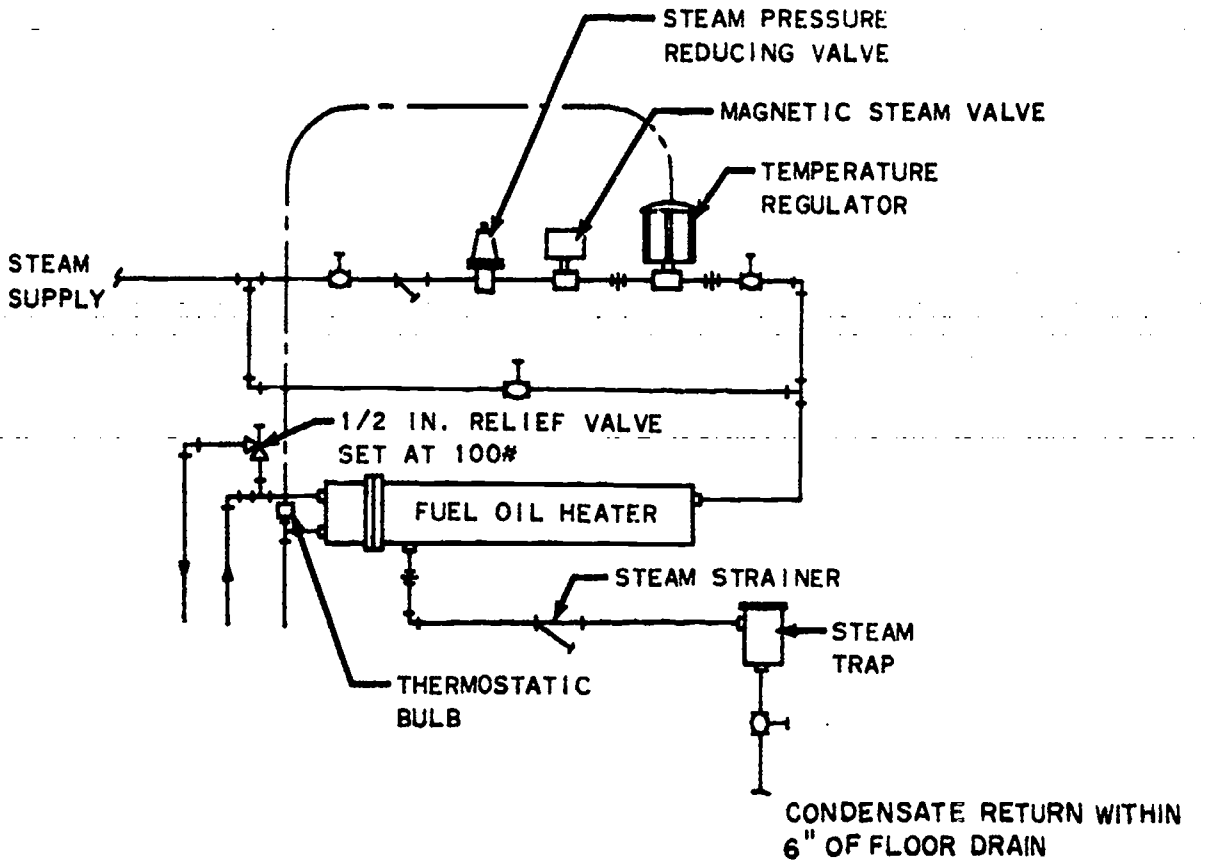



Figure 2-8. Steam control piping for fuel oil heater.

the oil, and consequently carbonizing of the heater. This will reduce both oil flow and temperature and may also, during shut-down periods, cause cracking of the heater and a possible fire.

b) Steam heaters in the fuel line are constructed with a steam coil inside the heater (Figure 2 - 7). The steam discharge from these heaters should not be returned to the boiler since a leak in the heater could introduce oil into the boiler. Steam heaters are usually equipped with a steam temperature regulating valve (Figure 2 - 8).

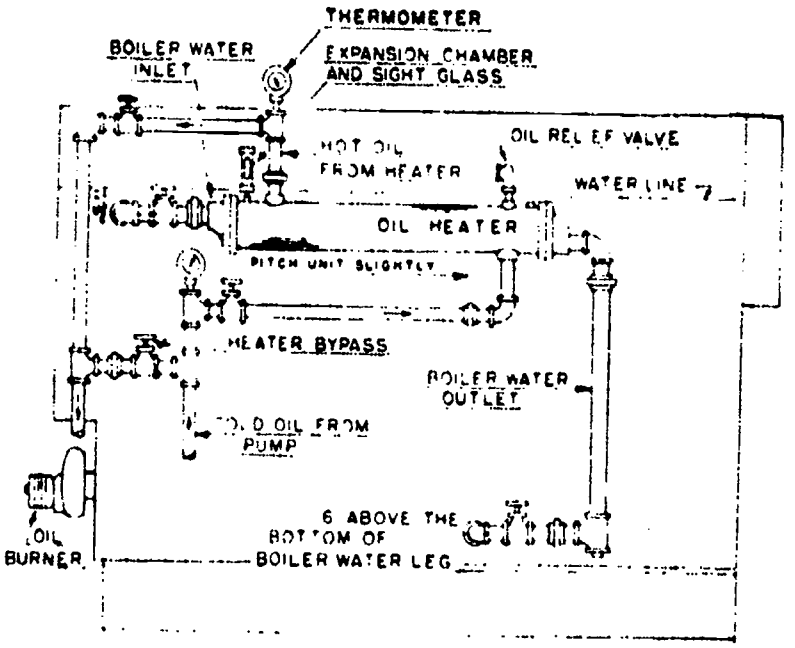





Figure 2-9. Piping for hot water oil heater.

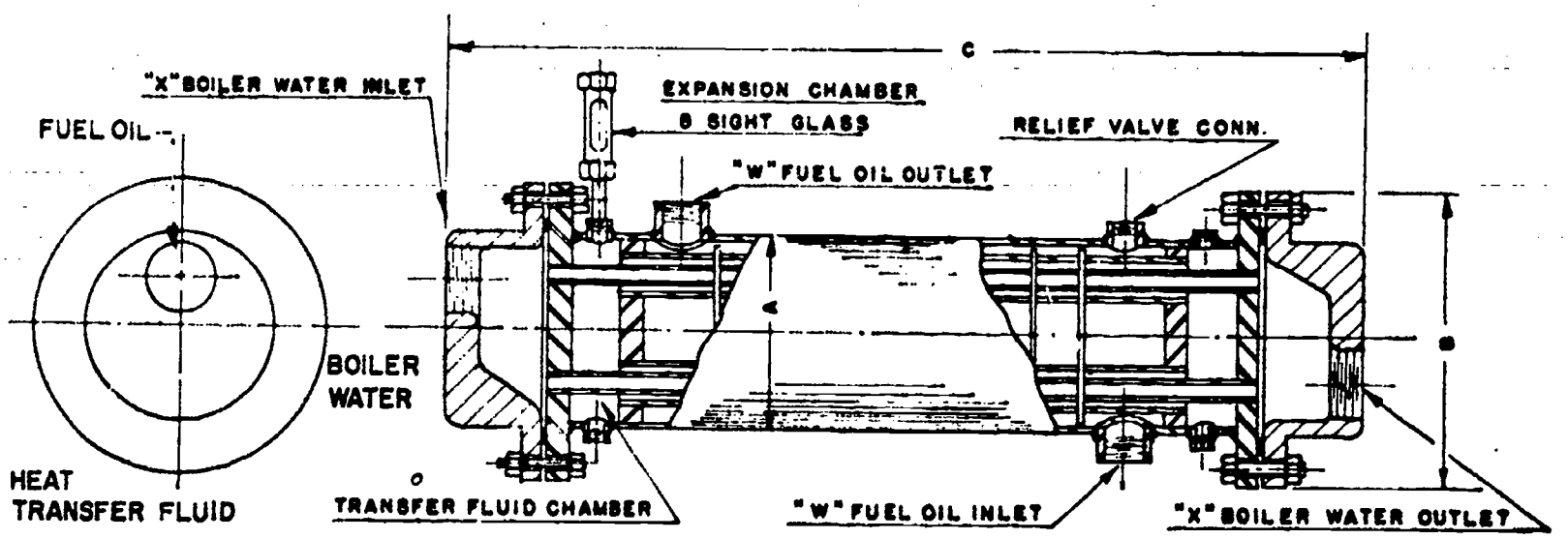



Figure 2-10. Hot water oil heater.

c) Hot water heaters (Figure 2 - 10) are normally below-the-water-line heaters. In this type, the heater is placed on the outside of the boiler below the normal water line. The heater consists of three sections.

One section has a nest of tubes through which oil flows. Another section of tubes allows boiler water to circulate. Separating both sets of coils is stagnant heat transfer fluid. Any change in color of the fluid or pressure indicates a leaking coil.

A check must be kept on fuel oil temperatures to be sure the heater is working. The heater should be cleaned at definite intervals by a serviceman. Frequent flushing through the drain valve is recommended to prevent a buildup of boiler water sediment.

Electric Pipe Heating

There is only one purpose for electric pipe heating, and that is to keep fuel oil warm enough for pumping. The system uses electric current (low voltage and low amperage) to heat the piping.

Oil in the pipe receives heat from the electrified piping. A thermostat maintains the desired temperature (approximately 125°F) by sending a signal to a control panel. The control panel starts a stepdown transformer that has electric cables connected to the piping.

To have a completed electric curcuit, insulators are placed in the pipe flanges. These insulators are also used to prevent the electric current from entering the burners, pumps, and boilers. Therefore, the electricity is kept only in the suction and return piping. If the plant is large, the piping is divided into separate individual electrical sections.

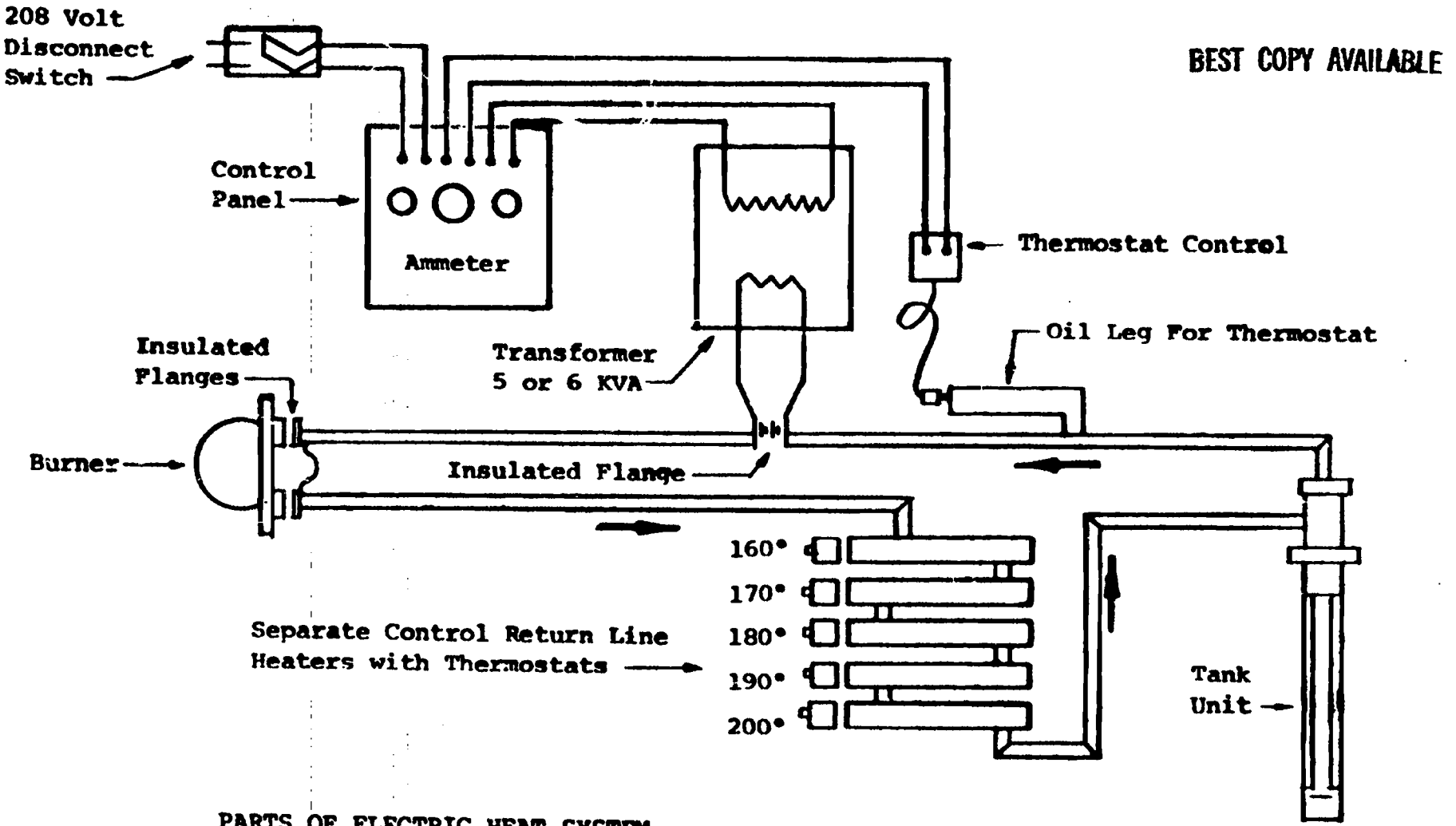
To make sure that the fuel pump suction line can pick up oil from the tank, electric return line heaters are placed in series (Figure 2 - 11). These boost the oil temperature before it is returned to the tank. A special heater mixes the hot oil with the cooler oil in the tank. Oil temperature at the pump suction line becomes approximately 125°F.

The electric pipe heating system is only used for heating the oil in the suction and return piping. This assures a supply of warm oil for circulation. However, the oil temperature should be raised to at least 180°F in the electric oil heater near the burner. This is needed for proper combustion.

This system can be adapted for use in any oil circulating system. It is not considered a part of the oil burner control wiring.

## PRIMARY AND SECONDARY THERMAL ELECTRIC CIRCUITS






### PARTS OF ELECTRIC HEAT SYSTEM

1. TRANSFORMER - 5 or 6 KVA (using 9 to 18 volts).
2. CONTROL PANEL - with ammeter (21 to 25 amps), magnetic contactor and overload relay.
3. THERMOSTAT - to maintain control of 120 degrees F.
4. TANK UNIT - for mixing hot return oil.
5. INSULATED PIPE JOINTS - to limit electric flow.
6. JUMPER CABLES - to continue electric circuit.
7. SEPARATE RETURN LINE HEATERS - individual thermostat control to boost temp. of oil before mixing in tank unit.

Figure 2-11. Electric pipe heating system.

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

## FUEL OILS, BURNERS, AND HEATERS

1. Oil heating fuels are classed by number from _____ to _____.

   Number _____ oil is a light distillate and low in sulfur content.

   Number _____ oil is a commercial heating oil which does not require preheating.

2. The flash point is the _____ temperature at which an oil will flash into flame momentarily when a flame is passed over its surface.

3. Viscosity is a measure of how easily an oil will _____.

4. If the pour point of a #2 oil in outside storage is too high, it may thicken and not _____.

5. A BTU is the amount of _____ necessary to raise the temperature of _____lbs. of _____ one degree Fahrenheit.

6. The specific gravity of a fuel oil is important because it is an indication of the _____ value or number of _____ in the oil.

7. Sulfur has no _____ on the heating value of fuel oil. It combines with air to form _____ when the oil is burned.

8. Number _____ oil is residual oil that requires _____ before it can be burned.

9. In a domestic or gun type burner the oil is delivered to the burner tip at about _____pounds of pressure. The grade of oil in this type burner is number_____.

10. A rotary cup oil burner may burn either # _____; #_____; # ____ oil.

    If # ____ oil is used the burner must be equipped with oil _____.

11. The steam or hot water leaving the heating coil of a fuel heater should be watched for signs of _____. This indicates a _____fuel heater.

12. Water may enter a fuel tank through the _____line.

13. Cold oil causes _____ and _____.

14. An electric heater for number 6 oil is normally located around or under the _____.

15. The cold oil interlock connected in the control wiring prevents the oil burner from _____ with _____ oil.

16. The fuel temperature from a number 6 oil tank should be about _____.

    The fuel temperature to the cup on starting should be at least _____$^{o}$F.

17. A broken cold oil interlock that permits starting a number 6 oil burner with cold oil will generally result in a _____ fire.

18. A faulty temperature control on a fuel heater that permits overheating may cause the oil to _____ in the heater.

19. A faulty thermostat that permits overheating of the oil may cause the heater casing to _____.

20. The purpose of an electric pipe heating system is to keep fuel oil _____enough for pumping.

## LESSON THREE

## OIL CIRCULATION SYSTEMS AND FUEL BURNING EQUIPMENT

To prevent air pollution from your oil burner, you must understand its operation. Knowing the parts of your equipment, where they are located and how they work helps you to get good performance and to eliminate smoke.

### OIL CIRCULATION

Adequate circulation of oil is fundamental to oil burner operation. After being heated enough to be pumped, oil goes from the tank to the burner, and unused oil is returned to the tank. The oil moves around the system under pressure, so that (1) heated oil is returned to the tank, and (2) air is kept out of the oil lines. Elimination of air in the lines prevents the flame from going out at the burner because of oil delivery interruption, and prevents the heaters from becoming vaporbound.

Two circulation systems will be discussed here. The non-integral circulation system (where the oil pumps are separate from the burner), and the integral system (where the oil pump is mounted on the burner and driven from the burner motor).

### NON-INTEGRAL OIL CIRCULATION SYSTEM

The parts of typical non-integral oil circulation systems for single- and two-boiler installations are shown in Figures 3-1 and 3-2. Refer to these diagrams while studying the following material.

#### Tank Shut-off Gate Valve

This valve closes the suction line going to the pumps. Where two or more tanks are installed, the shut-off valve is closed to the tank not in use. When the valve is closed, make certain that the return oil valve for the same tank is also closed. Not to do this would result in oil being added to the tank not in use, and none being removed. A serious overflow could result. The return oil shut-off valve is usually a two-way valve.

#### Thermometer .. On Oil Suction Line from Tank

For good oil circulation, the temperature of the oil coming from the tank should be 120° F, but for safety under 150° F. Check frequently.

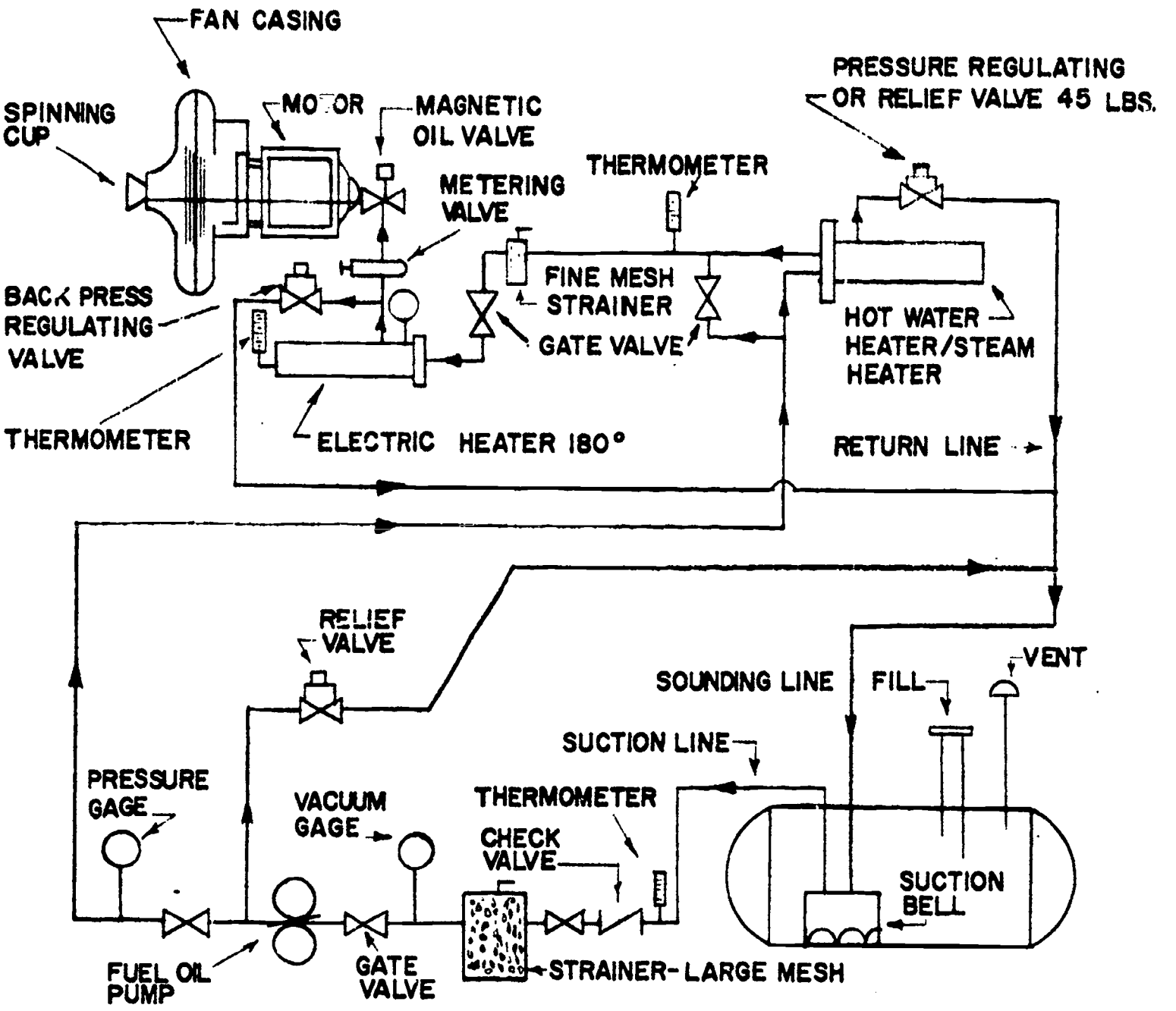



Figure 3-1. Non-integral oil circulation system for a single boiler.

Check Valve

The check valve is installed to prevent siphoning of oil back into the tank when the pumps are shut down. This prevents the oil from being drained out of the pump, and also prevents air from entering the system.

Vacuum Gauge

Frequent reading of the gauge can prevent trouble. For each plant the readings can vary. Record the reading when your strainers and oil tanks are clean. Any change from that reading

indicates trouble that can be corrected before a complete shut-down occurs.

A low vacuum may indicate:

1. No oil in the tank.
2. Worn pump gears.
3. Worn pump packing.
4. High oil temperature.
5. Air in the suction line (broken pipe or fitting).
6. Loose strainer cover or worn gasket.

A high vacuum indicates:

1. A clogged strainer.
2. Dirt and sludge in the tank.
3. Closed suction valve.
4. Suction pipe too small.
5. Oil pump too far away from the tank.
6. Clogged vent.
7. Cold oil.

Simplex or Duplex Strainer

When there is only one pump set, a duplex strainer is usually provided so that one strainer may be cleaned without interrupting the oil flow. The strainer consists of two sections each containing a wire mesh basket that catches the sediment from the oil tanks. A swing handle is used to change over from one section to the other. Use kerosene and rags to clean the basket, and make sure the cover gasket is in good condition before replacing. Never use extra leverage on the swing handle as this may damage the valve.

Vacuum Gauge

An additional vacuum gauge may be placed after the strainer. A high reading at this point indicates the need to clean the strainer.

Fuel Oil Transfer Pumps

These are rotary positive displacement internal gear type pumps which are usually driven by a motor and belt assembly at about 300 R.P.M. If the pump discharge is closed, the pump will continue to build up pressure until it ruptures. Because of this, a pressure relief valve is always placed in the line before the discharge valve of the pump.

The fuel pumps contain two finely machined gears that mesh and squeeze the oil. The fuel oil in the pump lubricates these gears. It is important not to run the pump dry, or to create a

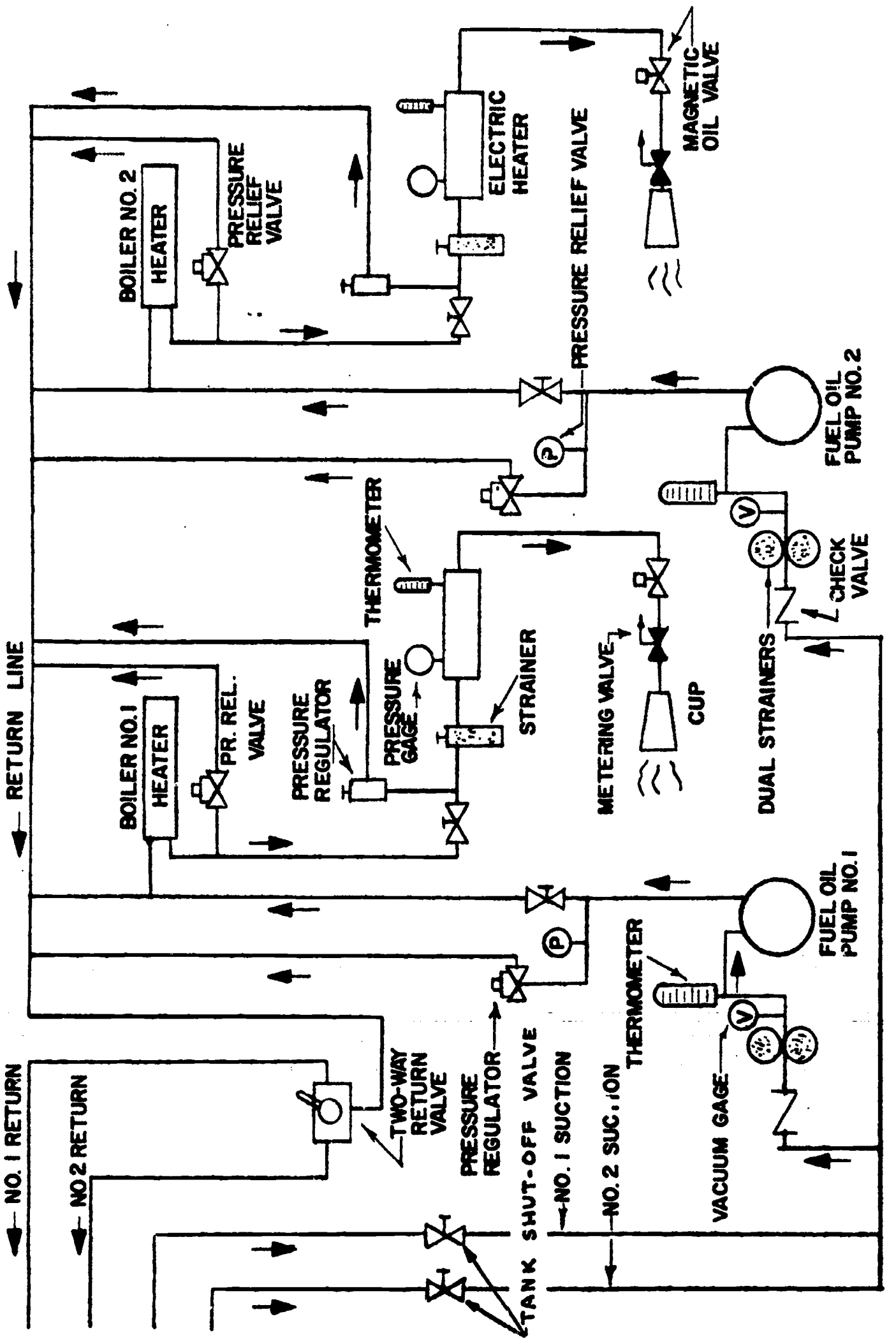



Figure 3-2. Non-integral oil circulation system for two boilers.

vacuum high enough to cause a vapor or air-bound condition. Care should be taken to lubricate the pump shaft and keep the packing in good condition. Inspect the packing regularly, change when conditions indicate leakage, or at least once a year.

Relief Valve or Pressure Regulating Valve

This valve protects the pump and discharges oil to the return line going into the tank. The relief valve is spring loaded, and can be set by removing a protective bonnet. The valve stem is turned after releasing a lock nut. A pressure regulator is essentially the same as a relief valve except the valve stem has a valve wheel with a thumb screw lock nut. The pressure regulator is, therefore, easier to adjust since no tools are required.

The relief valve or pressure regulator located near the oil pump is set at the pressure required by the burner manufacturer for the proper operation and should not be changed.

Discharge Valve

This valve is used to close the discharge line from the oil pump, when more than one pump set is installed.

Pump Pressure Gauge

This gauge is only an indicator. The relief or pressure regulating valves control the pressure in the system.

Oil Heater

Oil from the discharge of the pump is sent to an approved hot water or steam heater. Electric heaters may also be used in series with a steam heater. These are called heater sets. The temperature of the electric heater is set approximately 15° F less than the steam heater so that it cuts-out when there is a sufficient supply of steam. The auxiliary parts of a hot water oil heater and their purposes are:

1. Gate Valves: To permit taking the heater out of service (installed on the inlet and outlet and bypass)
2. Blow-Down Valve: To flush the water side of the hot water oil heater
3. Thermometers: To indicate temperature rise across the heater (installed at the oil inlet and outlet of the heater) NOTE: Some systems may have only one thermometer which sould be at the outlet.
4. Relief or Pressure Regulating Valve: Returns excess oil to the tank to relieve over-pressure

The average temperature in the oil heater should be high enough for reliable circulation. Average pressure on the relief valve at the heater outlet should be sufficient to deliver oil at pressures required by the oil burner manufacturer.

Burner Strainer

The warm oil from the hot water heater or steam heater passes through a fine strainer (located adjacent to the burner) where fine particles are trapped. Clean the strainer regularly using light oil or kerosene. Make sure the oil pump is not running, and the gasket is securely in place. Slowly open the shut-off valve after the cover has been replaced, and check for leaks. Clean up any spillage.

Electric Heater

Oil from the burner strainer enters an electric heater near the burner where the oil is heated to a constant temperature of 180° F or higher, as required for proper burning. This heater may be equipped with two thermometers, at inlet and outlet of the heater, and a pressure regulating or relief valve through which excess oil is sent to the return lines.

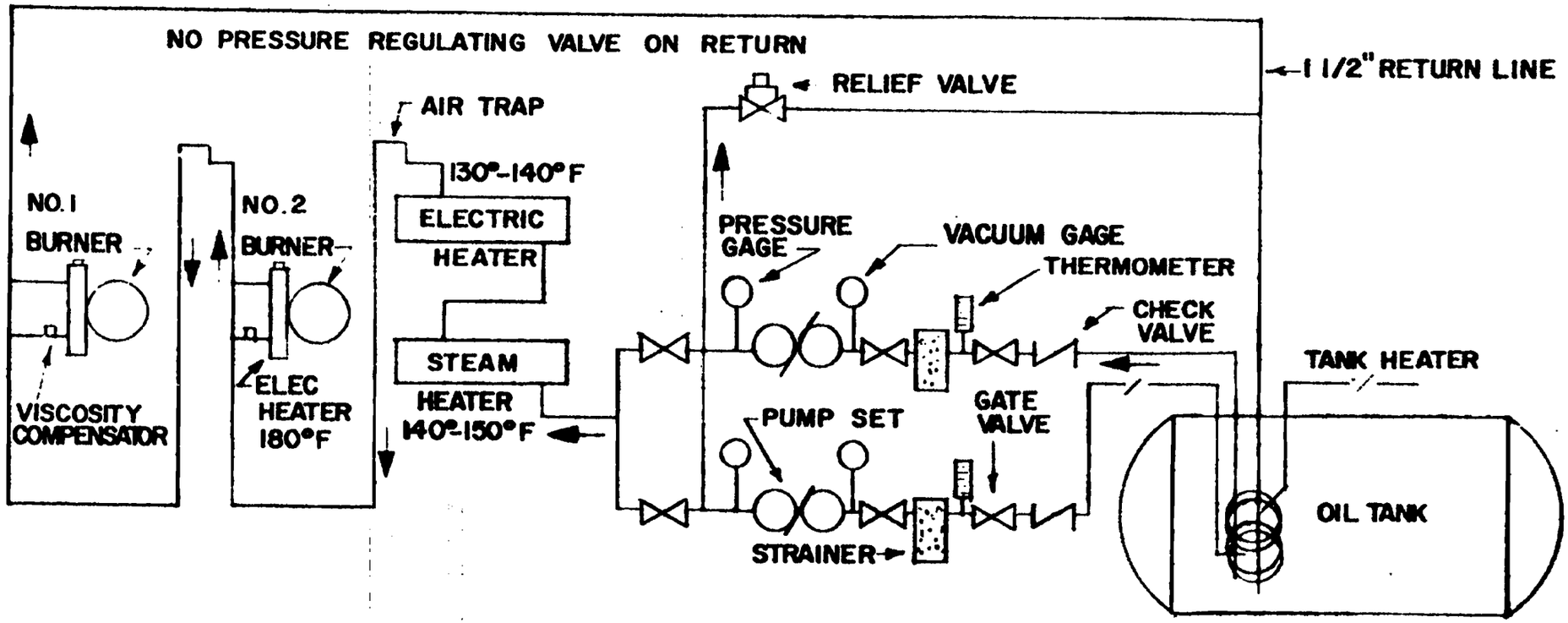
The pressure regulating valve is generally set for a pressure high enough to insure a steady flow of oil to the cup and flow-back to the tank, the actual pressure depending upon the burner used. This regulating valve is sometimes known as a back pressure valve.

As this heater is closest to the spinning cup before the oil is atomized, the heater has two controls for proper regulation of the burner: (1) A temperature control to start and stop the flow of electric current to the heating elements. (2) A cold oil interlock to prevent the oil burner from operating unless a minimum oil temperature is attained for starting. This control is sometimes known as a reverse-acting aquastat or a cold oil control.

Metering Valve

The heated oil from the electric heater travels to a metering valve. This valve is linked with the primary and secondary air dampers. The linkage is adjusted for the proper smokeless burning of the fuel oil. The right amount of air is then supplied with the oil entering the spinning cup for atomizing. If the amount of oil is changed, the linkage will vary the amount of air. This is known as the air-oil ratio.

Varying the oil through the metering valve according to steam pressure is known as modulation.




*NOTES:*

*1. EACH PUMP SET IS CAPABLE OF SUPPLYING BOTH BURNERS AND RETURNS WARM OIL TO TANK.*

*2. BURNER WITH VISCOSITY COMPENSATOR DRAWS OIL FROM LOOP INTO VISCOSITY COMPENSATOR DUAL PUMPS (MOUNTED AT BURNER) AND METERS THE OIL. IT ADJUSTS FOR VISCOSITY.*

*3. FROM VISCOSITY COMPENSATOR- OIL GOES TO AN ELECTRIC HEATER (ON BURNER) AND TO A SPRAY TIP ON CUP.*

TANK ROOM HAS NO PIPE INSULATION ON STEAM LINES PASSING THROUGH

Figure 3-3.
Diagram of a loop system with viscosity compensator on each burner, no pressure regulating valve in return line.

Magnetic Oil Valve

Oil from the metering valve moves on to the magnetic oil valve. The function of the magnetic oil valve is to start or stop the flow of oil to the spinning cup.

Spinning Cup

The cup spins rapidly, breaking the oil into fine droplets. These are then mixed with the proper amount of air, ignited, and burned in the combustion chamber.

INTEGRAL OIL CIRCULATION SYSTEM

We have studied a circulation system where the fuel oil pumps are separate from the burner (non-integral circulation or transfer pump system). Let us look at a system where the pumps are mounted on the burner (integral circulation system, Figure 3-4).

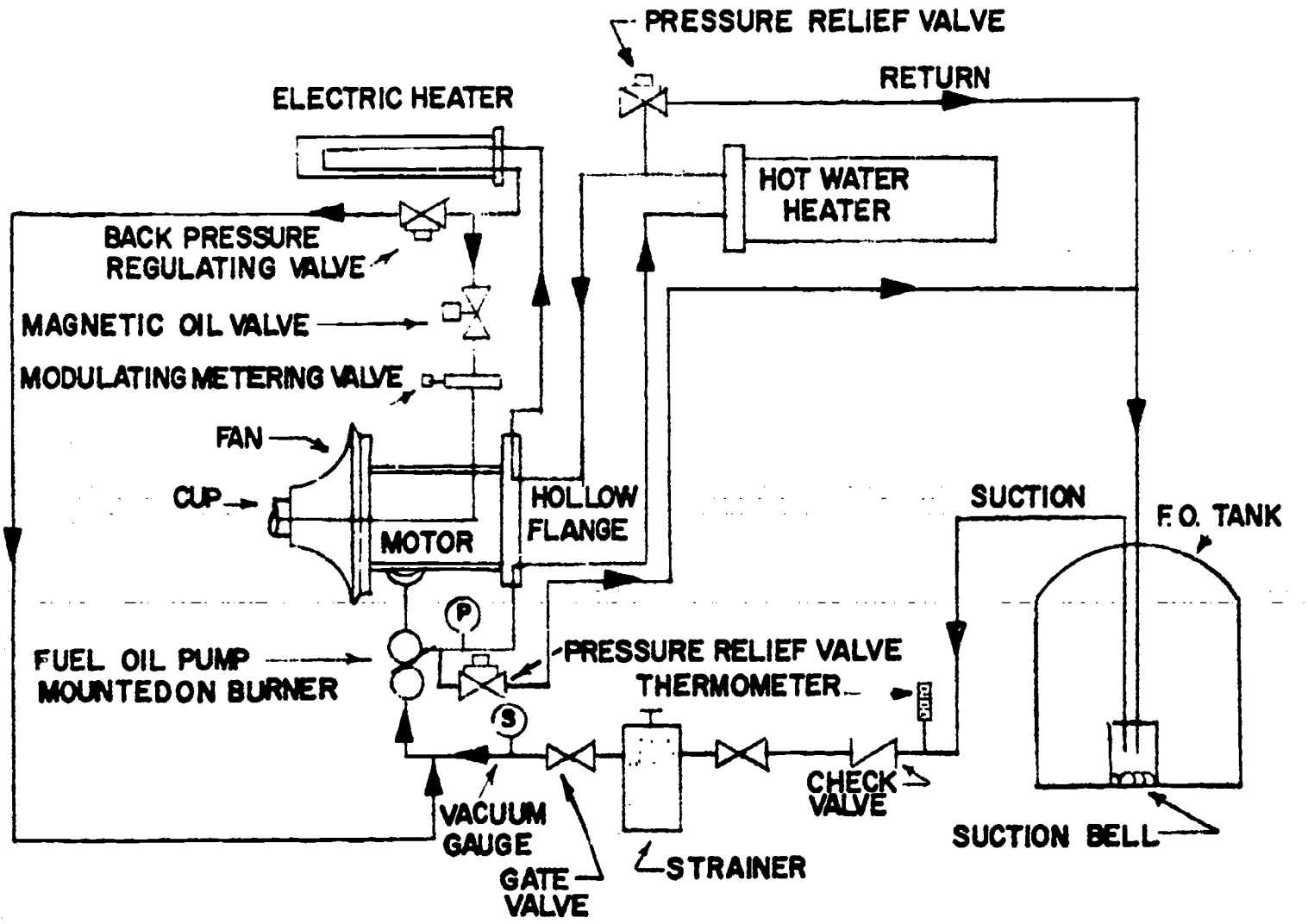



Figure 3-4. Integral oil circulation system.

When the burners are located near the fuel oil tank, the fuel pump can be mounted on the burner and driven by a worm gear on the burner motor shaft. The circulation is essentially the same as the non-integral system.

Starting at the fuel oil tank, oil flows to a strainer, to the pump on the burner, through a hollow flange on the burner, to the hot water or steam heater, back through the hollow flange to the electric heater, then to the cup or the return line.

ASSIGNMENT

On graph paper, draw a simple diagram of the oil circulation in your plant. Include temperatures and pressures on the equipment.

FUEL-BURNING EQUIPMENT

BURNERS

Many large oil burner systems use the horizontal rotary cup burner, which will be discussed here. A cross-sectional view of a typical rotary cup oil burner is shown in Figure 3-7, with details of the spinning cup and air nozzles in Figure 3-6. Refer to these diagrams while studying the following material.

Spinning Cup

Cup speeds vary from approximately 3450 rpm to 4700 rpm. The end of the cup protrudes approximately 1/4" from the end of the air nozzle. Fuel oil enters the cup through a pipe or hollow tube, and is either in a stream or spray. The rapid spinning of the cup breaks up the oil into fine droplets that mix with the primary and secondary air, as the oil is thrown off the end of the cup.

Any damage (scratch, dent or nick) to the cup will cause an improper atomizing effect making the spray difficult to burn properly. Smoke and unburned oil droplets will result. The size and shape of the cup depends on the capacity of the burner, and the shape of the furnace.

Burner Hinge

This fitting or hinge allows the burner to swing or pivot open without disconnecting the fuel oil piping. Oil flows through this hinge to other parts of the circulation equipment. (Figure 3-5).

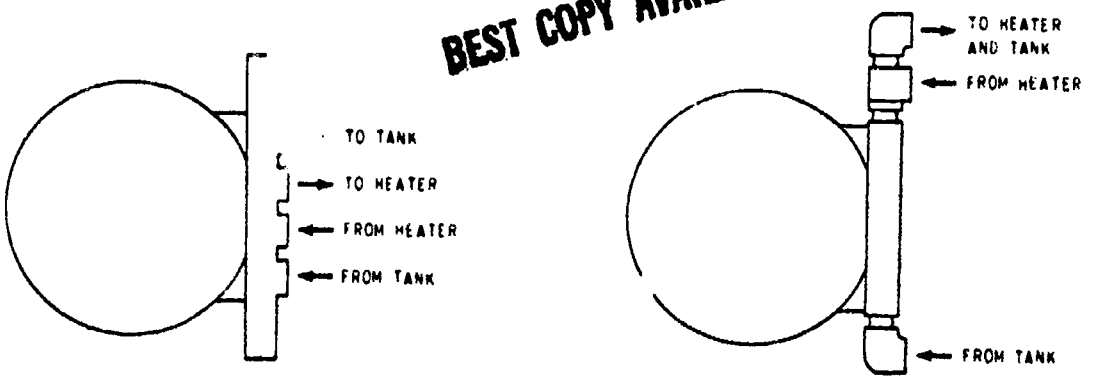



Figure 3-5. Burner hinges.

Primary Air

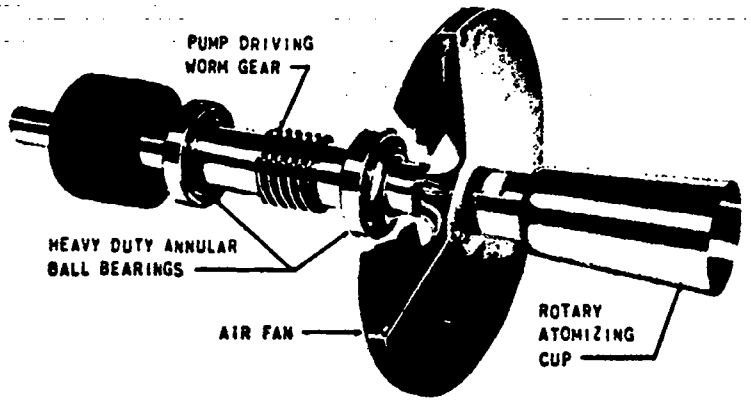
The burner motor drives a fully-housed fan receiving air from the primary damper (or shutter) located under or in the fan casing (Figure 3-7). Fixed directional vanes inside the casing cause the air to rotate in a direction opposite that of the spinning cup. The air mixes with oil from the cup giving a cone effect to the mixture. Air in the fan casing (primary air) supplies about 15% of the air necessary for smoke-free operation.

Too much primary air will blow the oil away from the cup and cause rough starts or pulsation. Too little primary air may cause the oil droplets to fall out of the spray pattern and stick to the walls or floor of the furnace.

On some burners a fan air flow interlock is mounted on top of the fan casing to make sure that the fan is creating the right air pressure for combustion. The fan air flow interlock indicates that the cup attached to the same fan shaft is spinning. If the fan and cup were not spinning, the control would sense the problem and prevent oil from entering the furnace.

Air Nozzle

Air nozzles have internal helical air vents that supply a uniform amount of primary air. This air mixes with the oil from the spinning cup. The nozzle is located at the rear of the fan casing.




SPINNING CUP

FRONT AND REAR VIEW OF AIR NOZZLES

Figure 3-6

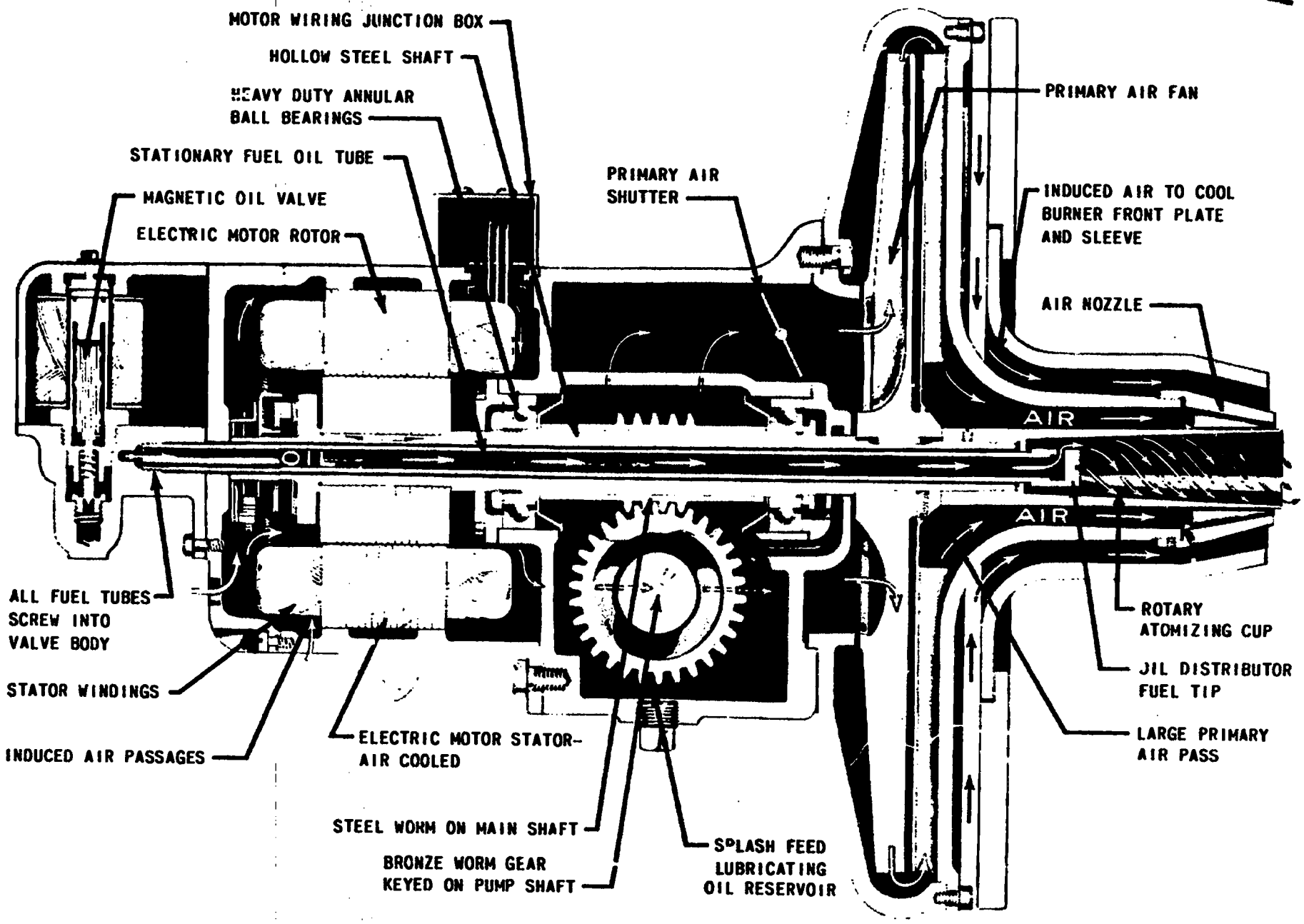



Figure 3-7. Cross-sectional view of a rotary cup burner.

AIR AND DRAFT SYSTEMS

Secondary Air Damper

The secondary air damper is located in the wind box under the burner, and supplies approximately 85% of the air for proper combustion. Air enters the furnace through this damper, and mixes with the atomized oil. The size of the damper depends on the amount of oil burned, usually 4 1/2 square inches per gallon per hour.

Draft

Changes in the weather can affect the draft in an oil burner or incinerator. For example, on a very calm day, the fire may act "sluggish"... it may not seem to "draw" or "pull" as it does on a clear windy day. A steady draft (negative pressure) is needed so that the flame will not be altered by any change in the weather.

The intensity of a natural chimney draft, usually measured in inches of water, is equal to the difference in weight between the column of hot gas within the chimney, and the weight of a similar column of external air.

The instrument used to measure draft is a draft gauge. A good draft in the furnace should be approximately -0.05 inches of water minimum (Figure 3-8). An automatic draft regulator in the chimney can maintain a draft of approximately -0.05 to -0.1 inches of water.

Draft can be produced in several ways:

Natural draft occurs without any mechanical aid. It is caused by the natural tendency of hot gases to rise.

Forced draft is produced by forcing air through the system under pressure. The blower employed is located at some point before the burning zone.

Induced draft is created by a fan in the uptake or flue pipes at a point following the burning zone. It is used when the natural chimney draft is not sufficient to carry away the products of combustion. Induced draft fans are usually located in the breeching, and start when the burner motor goes on. The fans must handle large volumes of hot gases, often laden with dust, and are, therefore, subjected to more severe service than forced draft fans or blowers. They are larger and operate at lower speeds.

When the pressure within the furnace is almost equal to that outside, the condition is called balanced draft. This condition is obtained by special arrangement of damper control, and prevents fluctuations of draft.

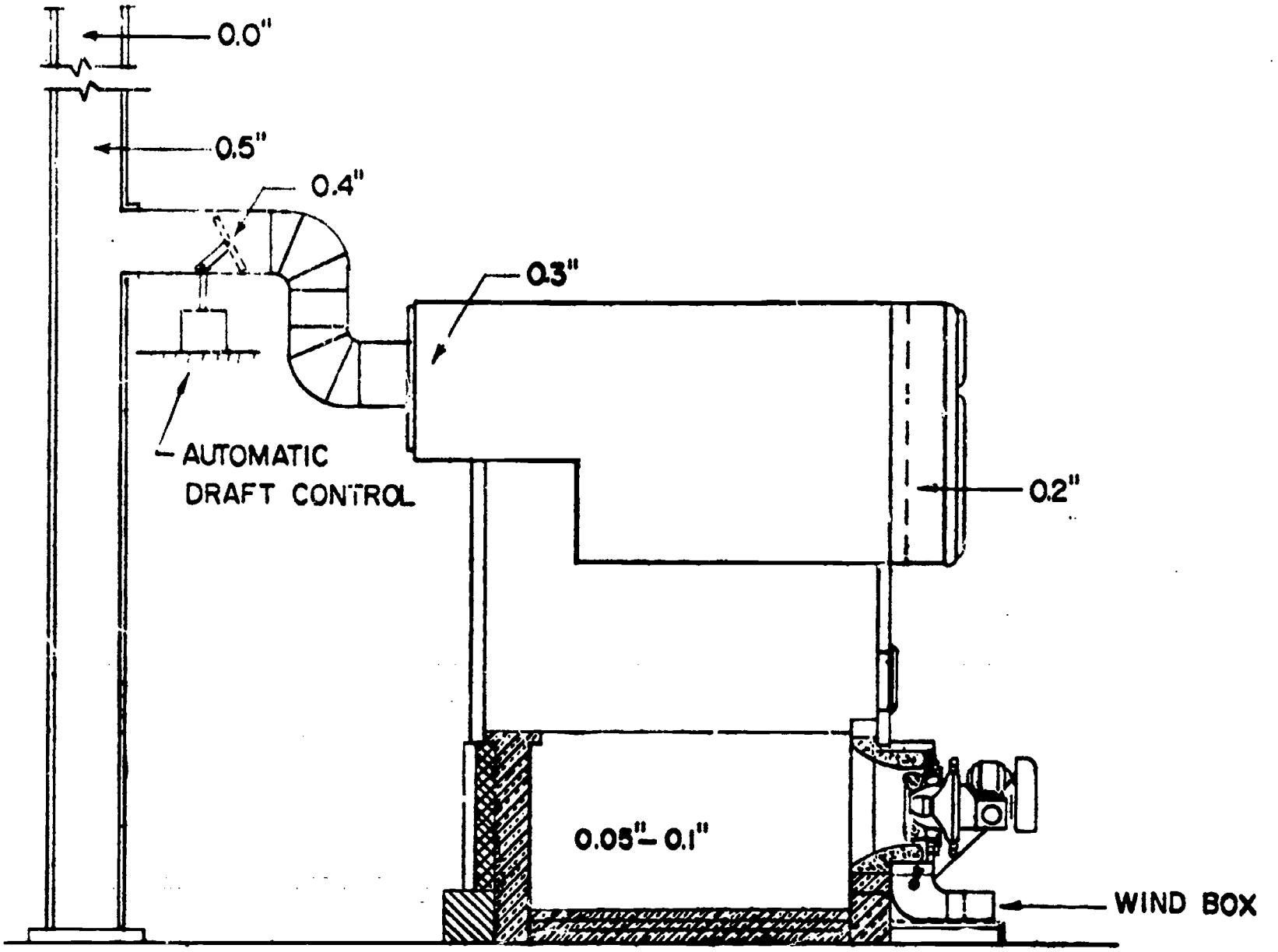



Figure 3-8. Draft loss through boiler.

No matter what draft system is used, it is extremely important that the furnace room have sufficient openings. Enough outside air must enter the boiler to support combustion and maintain the draft in the stack.

FURNACE

The furnace is that portion of a boiler where combustion takes place. It is constructed to permit complete combustion of the oil.

The construction of a furnace depends on how much oil is to be burned when operating at full capacity. Approximately 70 square inches floor area or 4 1/2 cubic feet furnace volume is allowed for each gallon of #6 oil burned per hour. High temperature fire brick or plastic refractory made from special clay make up the furnace lining. The brick has the ability to withstand and hold the high temperature inside the furnace.

The spinning cup or atomizer is selected to provide a flame that will fill the furnace without touching any part of it. If any flame touches the walls or floor it is called impingement. Small droplets of oil would stick to the firebrick, and start to burn the surface of the brick. Eventually, the insulating quality of the brick would wear away and have to be replaced. This would both waste money and cause boiler downtime.

Front Plate

The burner is mounted on the steel front plate. A sheet of asbestos behind the plate protects it from the furnace heat. When the burner is closed in the firing position, the air nozzle and cup fit into a preformed opening called a venturi. The venturi can be made from cast iron or formed by using refractory material. When the burner is swung open for maintenance or cleaning, a cover plate is used to close the venturi opening so that air will not cool the firebrick quickly. Fast cooling may cause the brick to crack.

Some openings on the front plate are:

(1) A special sight glass peep hole to observe the fire.
(2) Gas and electric ignition.
(3) Flame safety device.
(4) Secondary draft opening.

Walls

The side walls of the furnace are built with expansion spaces approximately 1/16" per linear foot. Any surface having worn or cracked firebrick can be patched with plastic brick for longer life. It is important to inspect the walls regularly through the sight glass or cleaning doors for signs of impingement. If impingement occurs the flame must be adjusted.

Some types of boilers are constructed with a furnace wall opposite the burner. This is known as the target wall. The care and inspection are the same as that needed for side walls.

Furnaces are designed to burn oil properly. Impingement and incomplete combustion cause unburned oil to cling to and damage the firebrick. Smoke also results. The following list gives some common causes and corrections for impingement and for smoke:

1. If there is too much or too little air, adjust air shutters or dampers.

2. If you are burning more oil than was provided by the design of the furnace, burn less fuel or have air/oil ratio checked and adjusted by a qualified service company.

3. If oil pressure is too high or too low, clean strainers, adjust regulating valves, or replace worn pump.

4. If oil is cold or has high viscosity, check oil heaters. Viscosity of oil may vary from batch to batch, even from the same supplier.

5. If cup collects dirt, clean regularly with solvent. (DO NOT USE ABRASIVES.) Check magnetic oil valve for leakage.

6. If cup is scratched or nicked, install recommended replacement cup.

7. If cup is loose on shaft, tighten securely.

8. If cup is misaligned, replace or realign.

9. If shaft or motor bearings are worn, replace bearings.

10. If sprayer plates or atomizers are worn or scratched, replace with the same type.

11. If air nozzles are dirty, clean regularly.

12. If modulation setting or air/oil ratio is improper, have qualified service company make adjustments.

Use extreme care in disassembling oil burners. Parts are easily damaged if improper tools or careless methods are used.

DRAFT CONTROLS

Dampers are used to regulate draft in the furnace and chimney.

A barometric damper is sometimes installed in the chimney. This damper has a weight that can be moved according to the draft gauge reading in the firebox. Any change in the chimney draft causes the damper to move and changes the amount of air entering

from the boiler room. The barometric damper acts as an automatic check damper. When starting a cold boiler, it is almost closed. As the stack becomes heated the draft "pull" becomes greater. The barometric damper then opens and "kills" the draft in the chimney. In this way, the draft through the furnace can be held reasonably constant under varying weather or stack conditions.

A better draft control consists of a draft sensor or indicator, a control panel and a damper actuator (motor). (See Figure 3-9.) The motor operates linkage that moves the damper according to the draft in the furnace. The draft sensor is set to the desired reading (usually 0.05 in. water). With any variation of this draft, an electrical signal is sent to the control panel which sends an additional electrical signal to the motor. The linkage then moves the damper, correcting and maintaining the draft setting.

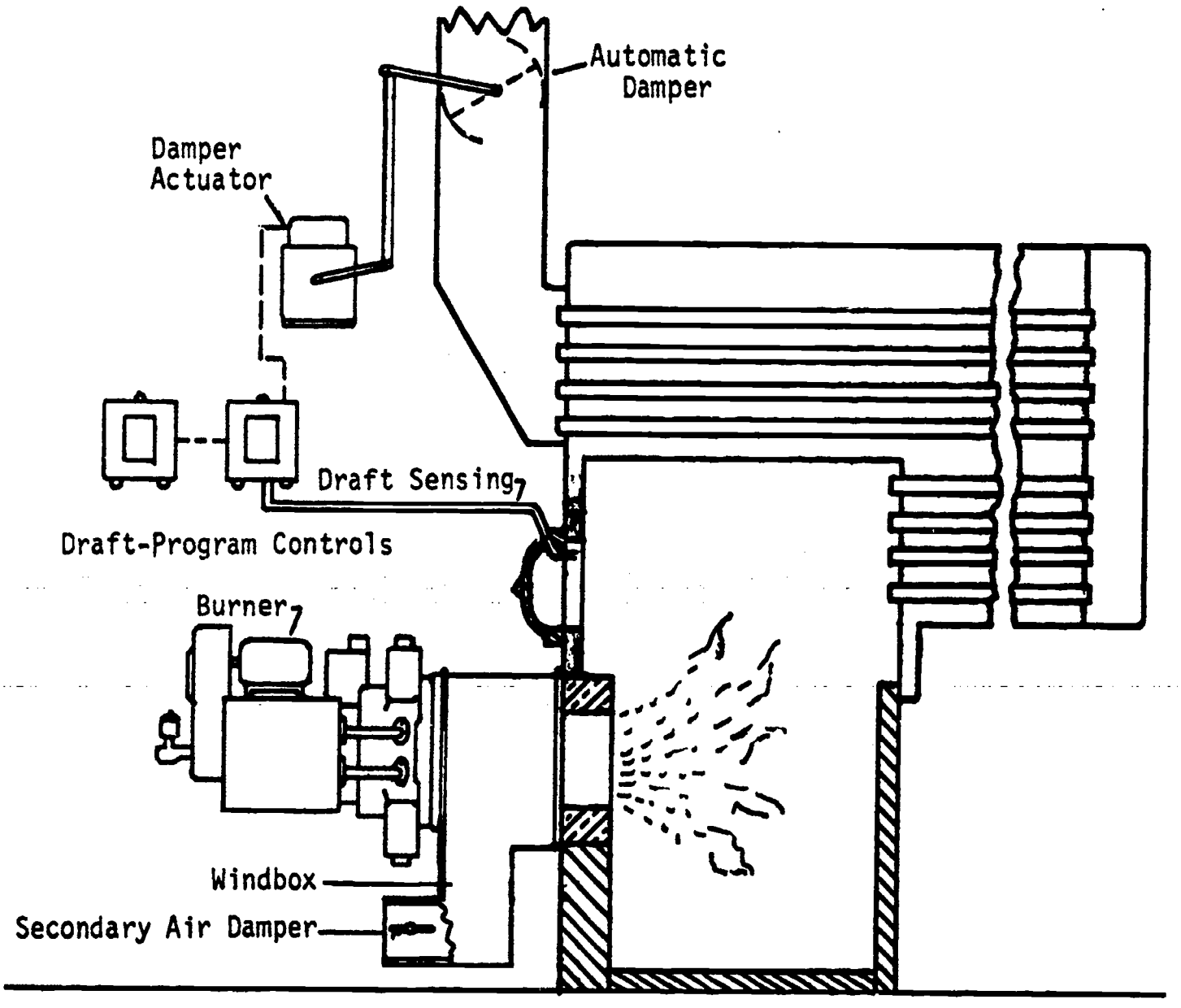



Figure 3-9. Draft control system with draft sensor or indicator.

The draft control has other functions as well, such as stopping the burner in case of low draft that can cause smoke. The draft controller is wired into the master relay and opens the damper before the burner motor starts, assuring a smooth light-off. After the initial start, the draft control maintains the setting by changing the position of the damper. After the flame cuts off, the damper remains open until the furnace is purged. The damper then closes and maintains the heat in the boiler, and the burner is ready for another safe start.

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

## OIL CIRCULATION SYSTEMS AND FUEL BURNING EQUIPMENT

1. Sludge in the fuel oil tank would show up as a high reading on the _____.
2. A _____vacuum gauge reading indicates no oil in the fuel oil tank.
3. The fuel oil _____catch dirt and particles from the oil tanks before the oil enters the pumps.
4. Fuel oil transfer pumps are _____type pumps.
5. A relief valve is placed in the discharge line to protect the _____.
6. The temperature of the oil leaving the fuel tank should be approximately _____° F.
7. An approved hot water fuel oil heater should prevent_____ from entering the boiler water in case of a heater defect.
8. A pressure relief or pressure regulating valve discharges oil from the hot water or steam heater back to the _____ _____.
9. Mounted on the electric heater near the burner are two _____ _____.
10. One purpose of the back pressure valve is to insure a steady _____of the_____to the spinning cup.
11. The rotary burner can be swung open on a_____ attached to the front plate.
12. When a burner is open for cleaning, a front_____ _____ is used to prevent air from entering the furnace.

13. A spinning cup or atomizer should be replaced if it is _____.

14. Air for the fan on the burner enters through the _____ _____ _____.

15. A windbox allows air to enter the furnace. It supplies controlled air through a _____ damper.

16. A function of the draft control is to stop the burner in case of _____.

17. One or two _____ and a _____ regulating valve should be mounted on the heaters.

18. Primary air mixes with the oil from the cup forming a _____ effect.

19. The strainer mounted near the burner has a _____ mesh basket.

20. To avoid large furnace repair bills, regular inspection of the _____ should be made.

## LESSON FOUR

## BURNER CONTROLS

Burners for number 6 oil need controls to regulate and provide safe operation of the equipment. Normally, each control has mechanical and electrical devices which are used in various combinations. Some of the more common devices used are described below.

### MECHANICAL CONTROL DEVICES

#### Bi-Metal Element

A bi-metal element consists of two strips of dissimilar metals having different coefficients of expansion (metals expand at different rates when heated). The metals are bonded together and, when heated, expand at different rates causing bending. When cooled, the metals return to their original position. The bi-metal element can be used as a timer or to open and close a control. This control principle is used in aquastats, thermostats, combustion controllers, and many other controls.

#### Float

A sealed metal ball filled with air, which will float on top of water, is called a float. It rises and falls with the water level. A rod attached to this ball connects with a simple on-off switch or valve. One application for a float is a low water cut-off.

#### Bellows

The bellows is a corrugated metallic container (like an accordion) that will flex. One end of the bellows is held in a fixed position. The other end is free to move when steam or air pressure is exerted inside. The free end is generally connected to mechanical linkage that operates a switch. A pressure control uses this principle.

#### Diaphragm

A diaphragm is a flat disc made of metal or rubber which separates two chambers. One chamber has a fluid to "bend" the diaphragm, the other chamber has a mechanical movement. This is used in pressure reducing valves, draft regulators and other such controls.

#### Spring

A spring is either coiled or flat and may be used to actuate

an electric switch. For example, a spring operated switch disconnects the electric current when the burner is swung open.

Capillary Tube

A capillary tube (very small bore tubing) contains liquid which expands when heated, (like a thermometer) pushing a switch on or off. This tube can be placed in a location where an ordinary thermostat cannot, such as in a refrigerator or hot room.

Centrifugal Switch

The centrifugal switch has a disc which is turned rapidly and will move against spring tension to make a contact. Single phase motors may use centrifugal switches for starting.

ELECTRICAL CONTROL DEVICES

Mercury Tube

Mercury, which is highly conductive electrically, is sealed in a glass tube. Two prongs are inserted into the tube but do not touch each other. When the tube is tilted, mercury covers the prongs. Electric current can then flow between wires attached to the prongs. Tilting the tube in the opposite direction, so that the mercury no longer covers the prongs, stops the current. In this manner, the mercury tube acts as a simple on-off switch. A mercury tube controls the flow of current in a pressure control.

Magnetic Coil or Solenoid

Current flowing through a coil of wire causes a magnetic field that surrounds the coil. If an iron rod were placed under the center of the coil, it would be drawn into the center and held there until the current were stopped. The iron rod would then fall.

This principle may be used to cause a valve to open or close automatically. Such a valve, used on the burner, is called a magnetic or solenoid valve.

Relays

Relays use the same principle as a magnetic coil. Electrical contacts are hinged so they will close when the coil receives current. The master controller includes relays that stop and start the flow of current to other electrical equipment such as motors, pumps, etc. The current through the relay is usually much smaller than the current to the other electrical equipment.

Potentiometer

A potentiometer is a device using a variable resistance to balance one voltage against another. A contact wipes across a coil

of wire cutting in or cutting out resistance. A modulator controller and modulating motor use this principle to regulate steam pressure in a boiler.

Lead Sulfide Cell

A lead sulfide cell senses infrared radiation when it "looks" at the fire. If the cell does not "see" a flame, it interrupts an electrical signal to the master controller and the oil valve is closed within 2 to 4 seconds. This avoids explosions by preventing oil from entering the furnace when there is no means of lighting the oil.

Ultra-Violet Sensor

The ultra-violet sensor is another device which "looks" at the flame. It "sees" the ultra-violet rays and generates an electrical current. As with the lead-sulfide cell, this sensor protects against explosions.

Flame Rod

The flame rod is another device to make sure that a flame is present. The flame touching the rod acts as a conductor to complete the circuit.

Photo-Cell

A photo-cell reacts to the density of a flame or color of smoke, causing a change in electrical current. Smoke indicators and smoke controllers function in this manner. The photo-cell can also be used to watch a flame or fire.

Micro-Switch

This small and highly sensitive switch is a simple momentary contact on-off switch. It takes very little pressure or movement to operate. Faulty wiring has been known to place these switches under constant pressure, finally reducing the spring tension until the switch flutters and the equipment malfunctions.

Amplifying Circuits

Amplifying circuits are used within a master controller to raise small electrical impulses to higher voltages that may be used to operate various controls.

BURNER CONTROLS

The mechanical and electrical devices just described are used to make up controls. Your boiler has controls so that it will

function safely, efficiently and automatically.

We can divide burner controls into three categories according to their usage:

1. Limits - to stop the operation of the burner.
2. Operating controls - to cause the burner to start, stop and make adjustments for good operation.
3. Safety controls (most limits are safety devices) - to constantly monitor for unsafe conditions in the burner and boiler.

Let us list some of these controls, then find out where they are located, what they do, and how they operate.

1. Limits:

   Disconnect switch

   Remote control switch

   Low water cut-off

   Hand reset pressure control

   Pressure control

   Motor plug or door latch

   Outside air louvres

   Low pressure gas control

   Cold oil interlock

   Combustion shut-off (smoke control cut-off)

2. Operating controls:

   Ignition system - electrodes, magnetic gas valve

   Magnetic oil valve

   Oil temperature control

   Master controller or combustion programmer

   Modulator

   Pressure and/or temperature limiting controls

3. Safety Controls:

Air flow interlock

Combustion scanner or flame safeguard device

Combustion control - safety switch or latch-out switch

Alarm

LIMITS

Limit controls are connected in series so that all limits must be satisfied before the burner can be started.

Disconnect Switch

A disconnect switch allows current from a main switchboard to flow, activating the burner circuit. Lines from the main switchboard contain fuses in case of overloads. A fused knife switch or a remote control relay can also be used to energize the circuit.

Remote Control (Emergency) Switch

A disconnect switch is located at each and every entrance to the boiler room so that it can be pulled in case of an emergency. A simple toggle switch may be used, or an enclosed switch with a glass cover. When the glass is broken, a spring-loaded button pops out and disconnects the current. The switch is labelled "Remote Control for Oil Burner." If there is more than one entrance (or exit) to the boiler room the switches are placed in series.

Low Water Cut-Off

In case of low water in the boiler, the burner must be shut down. The low water cut-off is operated by a float which drops when the boiler water falls below a safe level. The float connects with a mercury tube or a mechanical switch that can cut off the current and shut down the burner.

The low water cut-off has one pipe connection to the top of the boiler and the other below the water line. Any valves in this piping must be sealed in an open position. A blow-down is provided to clean boiler water sediment from the float chamber. The chamber should be blown when the boiler is under pressure, but the disconnect switch is turned off.

To test operation of the control, allow the boiler water to escape slowly instead of flushing rapidly through the blow-down valve. This slow release has the same effect as low water. The burner should cut out when the water reaches the low level.

Hand Reset Pressure Control

The hand reset pressure control is located above the steam drum. In case of excessive pressure, above normal operating pressure, but less than the boiler safety valve setting, the control will cause a shut-down. In must be reset by hand after the cause of such excessive pressure is corrected. A pipe from the steam space allows pressure to act on a bellows, causing a mercury tube to drop, cutting off current to the burner. The control is similar to a pressure control except that it must be reset by hand.

Pressure Control

This control is classified as a limit because it is connected in series with the limits. It is also an operating control because it starts and stops the operation of the burner under normal conditions. This control is located above the steam drum and receives pressure through a pig-tail pipe to prevent steam from entering the bellows. The bellows connects to a linkage that operates a mercury tube, thus controlling the current according to steam pressure. Two scales set the desired cut-in points and the pressure differential.

Operating pressures can be set with a screw driver. The setting of the cut-in, plus the differential setting, determines the cut-out pressure. For a steam heating system, the cut-in setting should be the smallest pressure needed to satisfy the heating needs of the building. The cut-out pressure should be the maximum needed, set high enough to prevent the boiler from starting and stopping too frequently.

Example: Cut-in 2 pounds, plus differential of 4 would give a cut-out pressure of 6 pounds.

Motor Plug or Door Latch

This limit control stops the flow of current when the burner is swung open for cleaning or servicing, or when the burner is not in use. A short piece of conductor, with a special connector, can be inserted into a junction box only when the burner is closed.

Use of a door latch is another means to ensure the current is disconnected when the burner is open. A spring loaded button switch, located on the burner front plate, pops out when the burner is open, interrupting the flow of current.

Outside Air Louvres

Fresh air for the boiler room must be supplied through a fixed or motor-operated louvred opening. The minimum NET free

area required is 1 square foot regardless of burner size; the actual net opening is based on 15 square inches net opening per gallon of oil burned per hour. Losses through a louvred opening are considered to be 50%; therefore, to get 1 square foot net area requires a gross opening of 2 square feet. The fresh air louvres must not be closed if the boiler is in operation. If the louvres are motor-operated, an interlock must keep them open when the burner is working.

Low Pressure Gas Control

On some installations, this control is used to make sure that an adequate supply of gas is available to start the main oil flame. If gas is present (a very small pressure is all that is necessary), the gas pressure acts on the bellows. The linkage keeps a mercury tube in the closed position. This control is the same as a fan vaporstat, except that gas, rather than air, activates the bellows.

Cold Oil Interlock

The cold oil interlock is located in the electric oil heater near or under the burner. This device prevents the burner from starting if the oil is too cold for proper smoke-free operation. It is also known as a reverse acting aquastat, a starting switch, or an ignition switch.

A bi-metal element inserted into a well inside the electric oil heater senses the oil temperature. If the temperature is high enough, electric contacts are made and the burner may start. The setting is usually about 15° F less than the normal oil heater setting. (If the oil heater is set at 180° F, the cold oil interlock or reverse acting aquastat would be set at 165° F).

If the oil temperature drops below the minimum for smoke-free operation, the control will stop the burner. This holds true both when starting the burner and while the burner is running.

Combustion Shut-Off

A combustion shut-off may be installed on oil burners to shut the burner off if the smoke density is excessive.

OPERATING AND SAFETY CONTROLS

The operating controls make sure that the oil is properly burned. As we have already seen, the burner cannot start if any limit switch is not satisfied. This is because the limit switches are wired in series. The circuit now enters a master controller, which sends signals in proper sequence to start the burner.

Before discussing this sequence, let us learn of the operating and safety controls that make the burner function properly.

## Ignition System

The atomized residual oil is automatically ignited by a gas flame. The parts necessary to start the oil flame are located on the front plate next to the burner. A gas tube containing electrodes runs through the plate so that the path of gas "hits" the atomized oil.

The ignition system consists of the following three parts:

1. A step-up transformer boosts the current from line voltage to 5,000 or 10,000 or 15,000 volts.

2. Insulated electrodes in the gas tube cause a spark to jump across a gap of approximately 3/8 inch.

3. Magnetic gas valve - When current is supplied, a magnetic coil lifts a free floating iron needle valve, allowing the gas to flow into the tube where the spark lights it. The gas flame will then soon light the oil. The magnetic gas valve only starts and stops the flow of gas.

On some circuits, the ignition is stopped after the main oil flame is established. This is called interrupted ignition. After lighting the main oil flame, the ignition should stop in approximately 15 seconds.

On a domestic burner using #2 fuel oil, gas is not necessary to ignite the oil. A transformer sends high voltage (5,000 to 15,000 volts) to the electrodes causing a spark. This spark is in the path of the oil and ignites it.

## Magnetic Oil Valve

When gas ignition has been established (and proven), the master controller allows the magnetic oil valve, located at the burner, to open. Oil then enters the atomizer. Therefore, the magnetic oil valve starts and stops the flow of oil entering the spinning cup. A key valve is sometimes used to regulate the amount of oil passing through the valve. When there is no automatic viscosity compensation, the key valve is used to cut down on the amount of oil passing to the cup. This can clear up a smoking fire.

The magnetic oil valve operates the same as the magnetic gas valve. An electrical coil sets up a magnetic field when current is applied, and lifts a floating needle valve, allowing oil to pass through the body of the valve.

## Air Flow Interlock

This control is found on top of the primary air fan casing, which is located at the burner. (As discussed in Lesson Three, the fan is driven by the burner motor.) A small amount of air pressure, acting in a bellows, causes a mercury tube switch to make contact. This control is wired in series with the magnetic oil valve, and will prevent the oil valve from opening if there is no air pressure present. This makes sure that the fan is spinning and providing primary air.

On some semi-automatic installations, a manual reset air flow interlock is mounted on the fan casing. The operator has a separate torch made of rags soaked in kerosene which he inserts into the furnace. When the torch is in position he depresses the interlock reset and opens the oil valve. The operator must remain to observe that the flame is well established.

The air flow interlock is also known as an air combustion control, or air vaporstat.

## Oil Temperature Control

The temperature of the oil in the electric heater located under or near the burner is controlled by a bi-metal element inserted in a well within the heater. This control moves a switch, or contacts, to start or stop the flow of current to the electric heater.

Sometimes a common bi-metal element moves both the oil temperature control and the cold oil interlock. However, the two controls have different purposes. The oil temperature control should be set to keep the oil at 180° F or above.

## Master Controller

The master controller, sometimes known as a combustion programmer or protective relay, is mounted on a main panel board or in special cabinets near the burner. This controller starts and stops the burner in a safe manner.

When all of the limits are satisfied (closed), and there is a need for steam pressure, a signal is sent to the master controller to start. The burner motor starts, and the ignition circuit is activated. After ignition is proved, the oil valve opens, and a flame is produced.

## Safety Controls

During the start-up period, a combustion scanner (flame safeguard device) such as a lead sulfide cell or flame rod,

"senses" the flame. If the oil does not ignite, or if the flame goes out too quickly, another part of the master controller operates to protect the boiler. This part is called the safety switch. Other names are latch-out switch, or warp-out switch.

When activated by the limits, the master controller allows current to flow into the safety switch. If the flame is not established within 30 to 60 seconds, a bi-metal element in the safety switch moves to cut off the burner. This switch must be reset by hand when a flame failure occurs.

When the scanner senses the flame, a relay operates and bypasses the safety switch.

The master controller also makes sure that a flame is present while the burner is operating. The safety switch becomes active and will stop the burner if the flame goes out because of unusual conditions.

The safety switch takes approximately 30 to 60 seconds to latch out under operating conditions, as well as under ignition conditions. However, on electronic controllers the sensing devices (lead sulfide, flame rod, etc.) will activate the master controller to close the magnetic oil valve within 2 to 4 seconds. This stops the oil from entering the furnace when no flame is present. At the same time, the safety switch will be activated to latch-out, preventing a restart until the adverse condition is investigated and corrected. In case of power failure or low water, the master controller will recycle or start again when that condition no longer exists. The modern controls will not recycle in case of flame failure; the reset button on the safety switch must be pushed to restart.

## Maintenance of Flame Safeguards

Sensing devices such as lead sulfide cells, flame rods, ultra-violet sensors, and photocells should be serviced by qualified service companies. Some maintenance tips that can be followed are:

1. Change the electronic tubes yearly.

2. Carefully blow out any dust with dry air.

3. Clean the contacts carefully using a "businessman's card." Do not use a file, sandpaper, crocus cloth or any other abrasive.

4. If an identical control is mounted for another boiler, the two controls may be interchanged. (Disconnect electric current before interchanging.) This will indicate whether or not the fault is in the internal part of the master controller. Have your serviceman make any repairs.

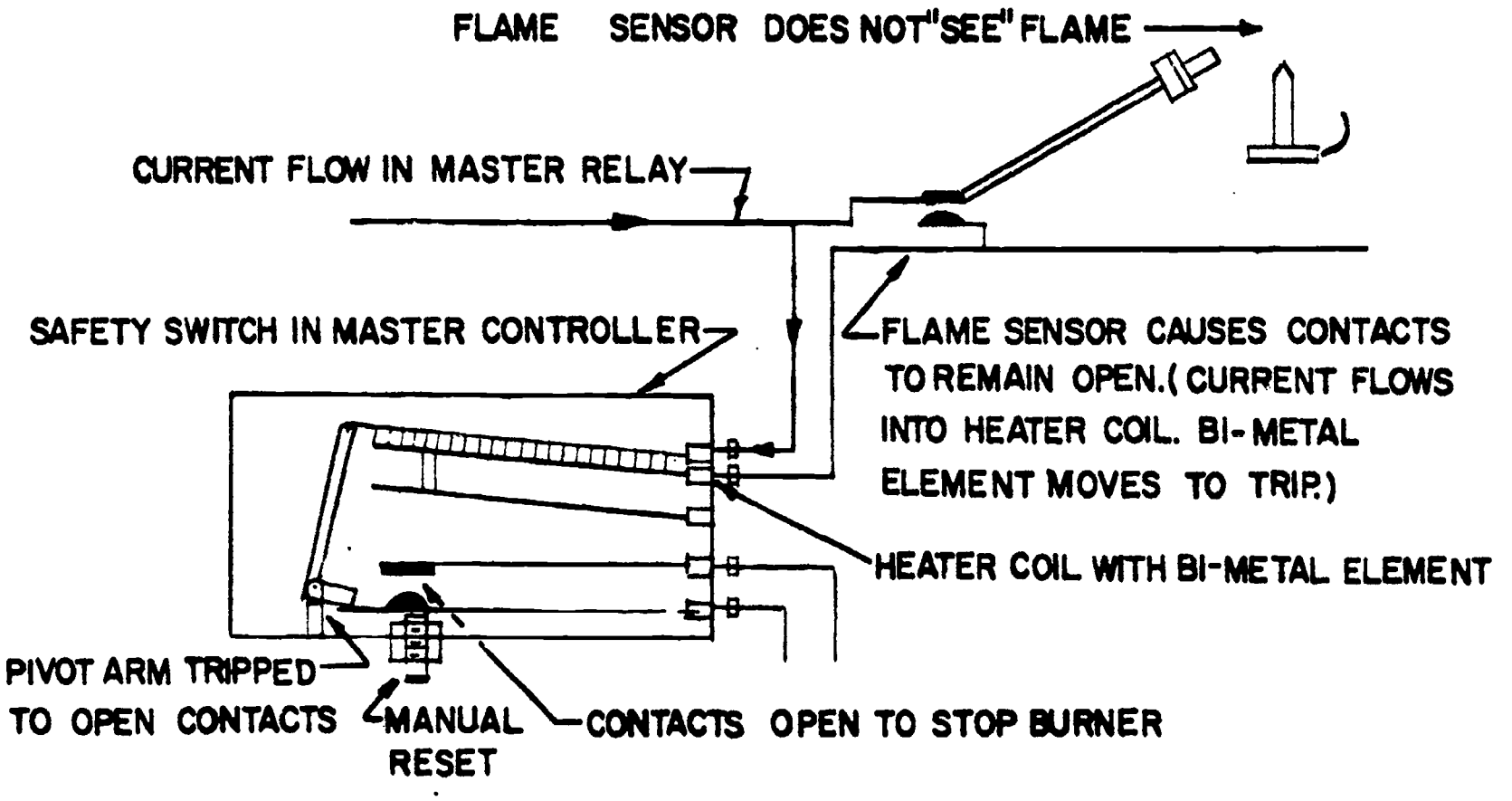



Figure 4-1. Safety switch has latched out; burner is stopped.

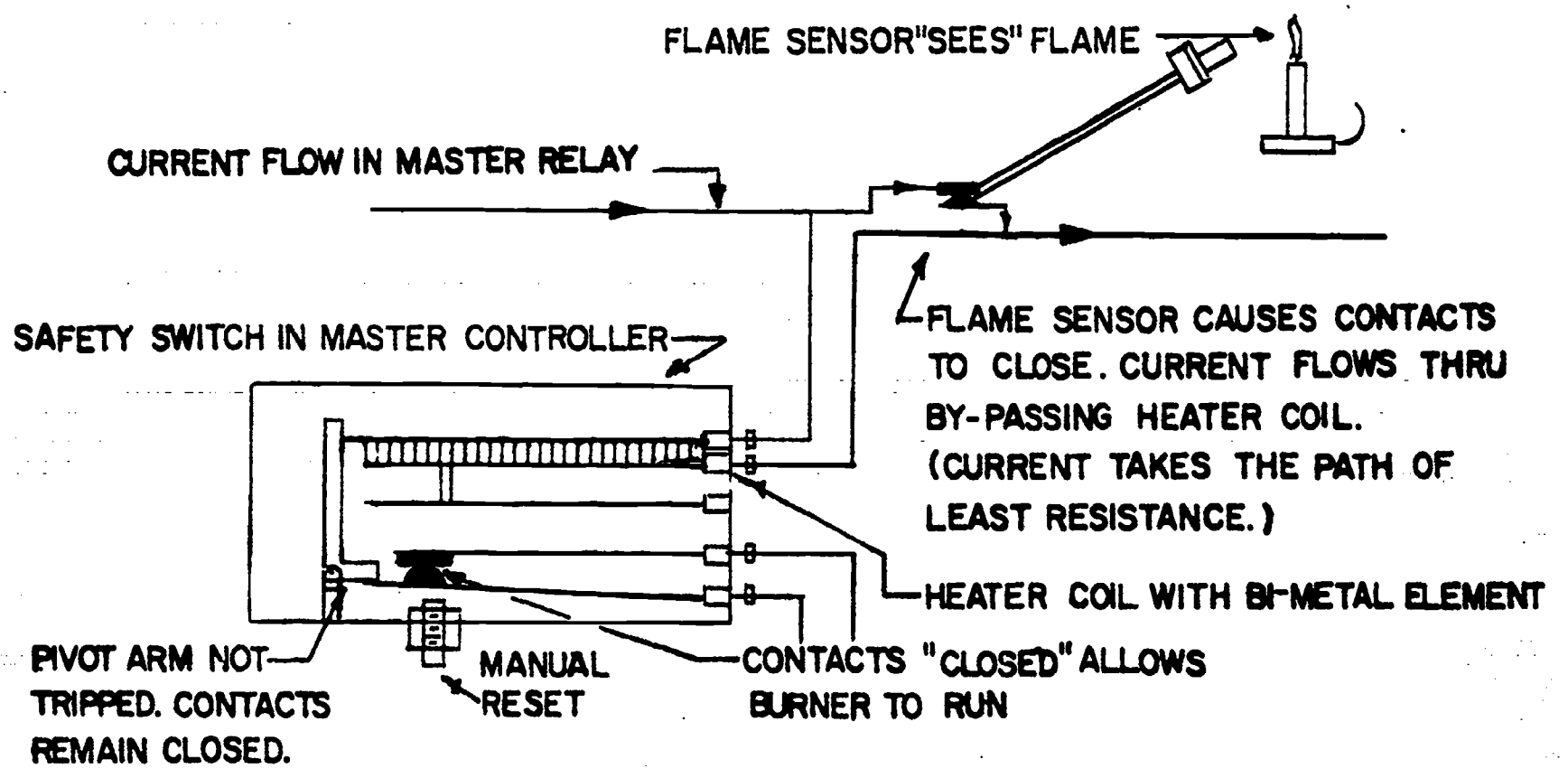



Figure 4-2. Safety switch in normal firing condition.

## Common Causes of Flame Failure

Check the following in case of flame failure:

1. Cold oil.
2. Water in the oil.
3. Poor ignition.
4. Low oil pressure.
5. Insufficient air.

If flame failure occurs too frequently, call a serviceman.

## Alarm

An alarm can be connected to the contacts of the safety switch. This alarm will sound when the safety switch is latched-out, alerting the operator to the abnormal condition. A red light may also be added.

## Modulation

Provision may be made for modulation (firing rate control) to be activated by the master controller. Modulation is desired on some boilers to prevent the burner from starting and stopping too often.

The pressure control described in the section on Limits starts and stops the burner according to steam pressure. Modulation attempts to prevent the burner from reaching the cut-out pressure by reducing the amount of air and oil in the burner. The modulator will not shut off or start the burner; it merely decreases or increases the flame. When starting, or when the boiler pressure nears the cut-out pressure, the modulator acts to decrease the flame. After starting, the modulator increases the flame to "high fire" to build up boiler pressure.

The system should have a guaranteed low fire start to make sure that the burner always starts at low fire after each shut down.

When we speak of modulation (the air/oil ratio) we are concerned with these mechanical parts connected by solid linkage:

1. A metering valve located in the fuel oil line going to the cup. The flow of oil may be increased or decreased, but never completely shut off by this valve.
2. Primary and secondary air dampers.

The mechanical parts of the modulator are controlled by the following electrical equipment:

1. The modulator control is mounted on the top of the boiler with a pig-tail pipe which allows boiler pressure to act upon a bellows. This device is similar to the pressure control, except that it can cause a potentiometer to send a signal to a modulating motor.

2. The modulating motor is low voltage (24 volts) and has a radial arm attached at the end of the motor shaft. Solid linkage connects the radial arm to the metering valve, primary air damper, and secondary air damper. The motor arm moves through an arc of approximately 160°.

   The modulating motor has a floating contact with two balancing coils. On a movement of the modulator control, the floating-contact causes the motor to turn. While the motor is turning, another potentiometer in the motor, with a wiper arm contact, moves to equalize the current. When the current in the motor and the control is the same, the floating-contact moves to a center position and the motor stops. Therefore, any movement of the control causes an equal movement of the motor.

3. The step-down transformer reduces voltage from 110 to 24 V, to operate the modulating motor and the modulator control.

SEQUENCE OF OPERATION

All oil burners must follow a certain sequence in starting. If a burner admitted oil without any means of ignition, unburned oil would fill the furnace. Then if the oil did ignite, the furnace would be too small to hold the extra volume of gas. An explosion would result. The least that could happen would be a "blow-back" (smoke coming out of the burner or rear door). If a large amount of unburned oil were admitted, the resulting explosion could rupture the brickwork, possibly causing a complete collapse of the boiler.

Therefore the master controller must start the burner in a proper manner under all conditions. This proper method is called a "sequence of operation." Figure 4-3 shows a typical programming sequence of operation. Each of the following steps must proceed in the order indicated. Steps ARE NOT interchangeable:

1. Pre-purge - Minimum 15 seconds - the burner motor starts, rotating the primary fan and pushing out any air or gases which may have remained in the furnace.

2. Pilot proving - Approximately 10 seconds - an electronic flame sensor makes sure that an electric spark and gas flame are available to ignite the oil.

3. Oil valve - The magnetic oil valve opens allowing oil to enter the furnace. The oil is ignited by the gas/electric ignition.

4. Trial for ignition - A maximum of 60 seconds is allowed for ignition. The safety switch of the master controller causes the gas and electric spark to stop at the end of the ignition period.

5. Normal firing period - Oil burner and related equipment maintain the desired boiler output.

6. Post-purge - After the pressure or temperature cut-out point in the boiler has been reached, the flow of oil is stopped and the flame is extinguished. The burner motor continues to operate, thus turning the primary fan to clear the furnace of any remaining gases. The post-purge period is approximately 15 seconds.

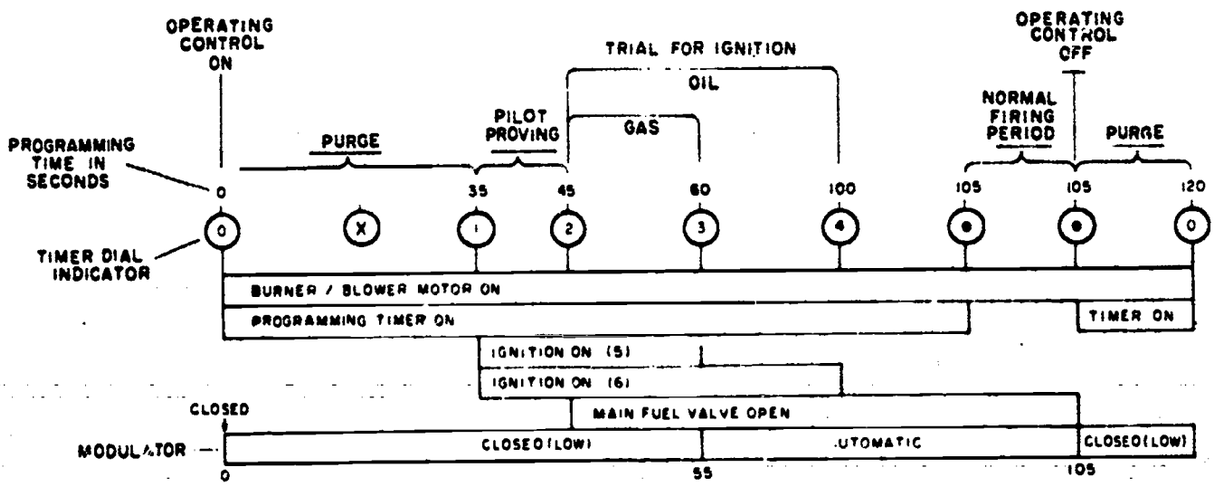



Figure 4-3. Typical programming sequence.

The Circuit

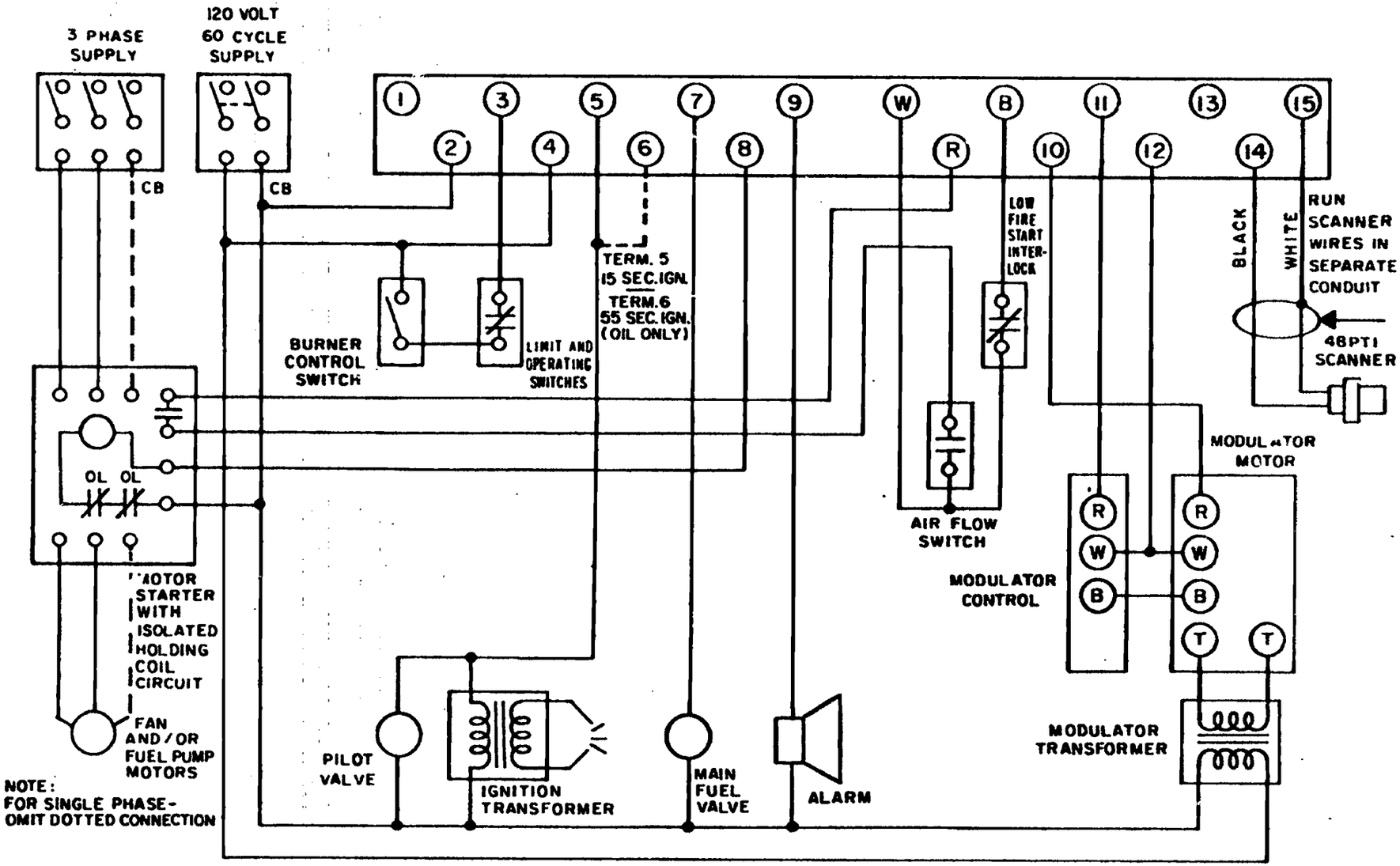
Closing the disconnect switch to the line permits current to flow through the limit controls, the oil thermostat, and master controller. This completes the circuit through the coil of the electric heater contacts. When the oil is heated to the correct temperature and the operating controls are calling for heat, the master control starts the burner motor. After the prepurge the master control turns on the ignition. The ignition is proved and the main fuel valve is turned on.

The electric-gas ignition is timed by the main controller timer. A short time after the flame is established, the ignition goes off. The burner is now in normal operation.

The temperature control disconnects when the oil is heated to the proper temperature by the hot water or steam oil heaters. It will automatically start again if the oil temperature drops.

The burner will cut-out when:

1. The pressure or temperature cut-out point has been reached (the burner can recycle)
2. There is a flame failure (manual resetting is necessary)
3. There is a power failure (the burner recycles)
4. Low water cut-off or limit switches operate (burner recycles)
5. Smoke control cut-off operates (manual resetting is necessary)




AUTOMATIC OIL BURNER – GAS ELECTRIC PILOT – WITH BURNER MODULATION

Figure 4-4. Typical wiring diagram.

## TYPICAL SEQUENCE OF OPERATION USING SEQUENTIAL DRAFT CONTROL

Refer to the schematic diagram, Figure 4-5.

1. Power is supplied to Terminals 1 and 2 of the program controller (R4127) and sequential draft control panel.

2. On call for heat by operating control, power is supplied to Terminal 3 of draft control panel which pulls in #1 relay in panel and drives draft control damper motor to a predetermined open position.

3. When draft control damper motor reaches open position, a circuit is completed through switch in motor powering Terminal S 2 of draft control panel.

4. If starting interlocks on burner are closed, Terminal 3 of R4127 is powered and burner sequence is started.

   (a) Pre-purge (after 10 seconds of pre-purge, Terminal 4 of R4127 must be powered)
   (b) Proof of pilot
   (c) Open oil valve (if pilot is proven)

5. When oil valve is energized from Terminal #7 of R4127, Terminal #5 of draft control panel is energized and #2 relay in draft control panel pulls in. Pilot valve and ignition is de-energized 60 seconds after oil valve opens.

6. The draft sensing device, in the sequential draft control panel, now controls the position of the draft control damper motor to maintain a constant over-fire draft regardless of fuel input or external conditions that would normally affect the draft.

7. The firing rate control (L91) positions the modulating motor (M931) as the load demand varies.

8. When the controller is satisfied, power to Terminal 3A of the draft control panel and Terminals 3 and 4 of R4127 are interrupted, dropping out all relays of the sequential draft control panel. The oil valve is de-energized and the R4127 continues for a 15 second post-purge. The draft control damper motor moves the draft damper to a closed position.

9. The system is now in the off position, ready for a restart of the sequence on a call for heat from the operating control.

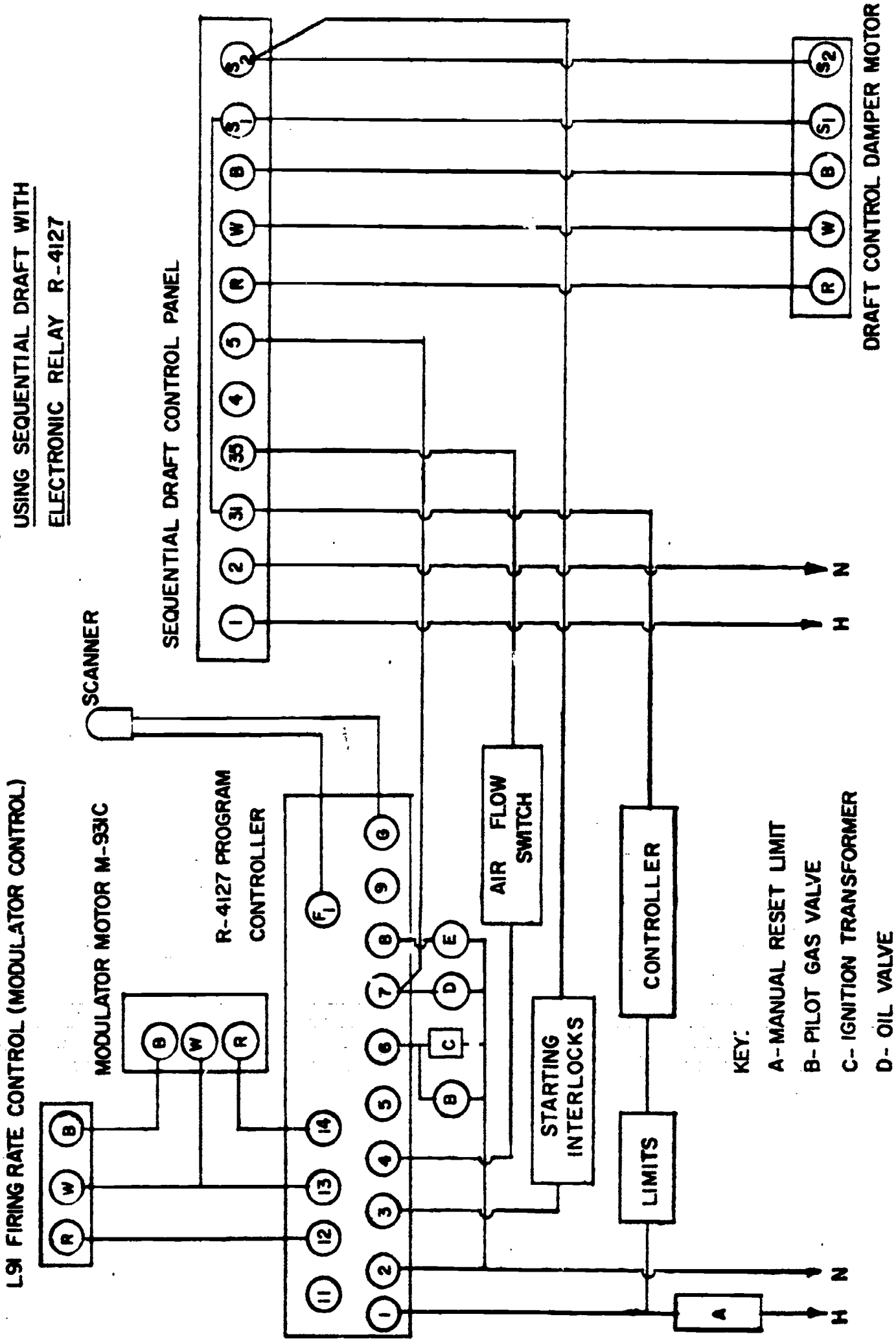

110 V. SCHEMATIC WIRING DIAGRAM
USING SEQUENTIAL DRAFT WITH
ELECTRONIC RELAY R-4127
SEQUENTIAL DRAFT CONTROL PANEL
DRAFT CONTROL DAMPER MOTOR
L91 FIRING RATE CONTROL (MODULATOR CONTROL)
MODULATOR MOTOR M-931C
R-4127 PROGRAM CONTROLLER
SCANNER
AIR FLOW SWITCH
STARTING INTERLOCKS
CONTROLLER
LIMITS
H
N
KEY:
A- MANUAL RESET LIMIT
B- PILOT GAS VALVE
C- IGNITION TRANSFORMER
D- OIL VALVE
E- MOTOR

Figure 4-5

## Combustion Controls Normally Used for Various Grades of Oil

### For number 2 oil

On-off control, barometric damper on each boiler breeching, stack switch or other approved means for flame failure shut-off, low water shut-off.

### For number 4 oil

Either on-off or high-low controls for capacities up to and including 15 gph. For capacities from 16 to 35 gph: modulating controls, sequential draft controls optional. Above 35 gph: sequential draft controls desirable.

### For numbers 5 and 6 oil

For capacities from 10 to 25 gph: either high-low or modulating controls and furnace draft controls. For capacities over 25 gph: modulating and sequential draft controls.

Note: All controls should be connected to 120 volt control circuits. They should not be grounded to control panel conduits or piping.

## Boiler Water Temperature Control

All combustion units subject to long shut-off periods, such as summer hot water load, reduced weekend heating load, etc., should have a boiler water temperature control. This control should maintain the boiler water at a minimum of 180° F.

## Summer Load Operation

Gas or light oil firing equipment may be required when the summer load is 1/4 or less of the winter load.

## Automatic Sequential Combustion Control Equipment

This equipment may perform the following functions:

1. Control the oil burner and related equipment to maintain the desired boiler output under all normal operating conditions, and prevent abnormal boiler pressure or temperature.

2. Meter the oil to the burner tip to supply the quantity required regardless of normal variations in oil pressure, viscosity or temperature. Oil should be circulated continuously at all times, through tank and oil heaters and burners, under temperature control.

3. Maintain the desired fuel-air ratio under all normal load conditions to assure complete and smokeless combustion, by coordination of the oil and secondary combustion air supply.

4. For natural or induced draft operation, regulate the outlet damper to maintain a low, uniform draft in the furnace under all normal load and atmospheric conditions.

   For pressurized firing, power regulate the outlet damper to maintain either a constant furnace pressure or a constant outlet pressure, depending on control hookup used.

   Note: Outlet damper may close completely with any of the above arrangements.

5. For multiple boilers, the combustion controls should automatically start, modulate, and stop the several boilers, in accordance with load swings, so as to maintain optimum operating conditions for all boilers in service, within the heat release values. The load swings may be taken by more than one boiler, provided none of the boilers operate at less than fifty percent capacity. Individual boilers should start on low flame, as the load increases and decreases respectively.

6. Oil fired equipment using Number 6 oil may include an approved smoke detection and alarm device designed to produce audible and visual signals when dense smoke is emitted. The shut-off device will operate to stop the burner within two minutes if the smoke density is not reduced. The smoke alarm should be accessible for cleaning and servicing, with ladders or platforms provided when required. For pressurized firing, means for sealing the smoke detection device to prevent blowout of combustion products should be provided.

Test for Fuel Oil Metering Device

The following test may be used to check whether the fuel oil metering device can supply the right quantity of oil regardless of normal variations in pressure, viscosity or temperature:

1. Shut off the oil heaters on the remote suction or return line to reduce suction line oil temperature by approximately 100° F, or to the minimum temperature at which the oil can be pumped with no apparent change in the firing rate.

2. Use a gate valve and relief valve bypass in the oil return line to vary the return line back pressure to the metering device by at least 25 psi above or below the normal pressure.

During this test, there should be no readjustment of the burner or linkage, and no change in the firing rate.

Fail Safe Elements for Number 6 Oil Burners

1. Gas pilot with spark ignition and flame failure shut-off.

2. Boiler pressure or water temperature activated control plus low fire start interlock.

3. Over pressure and low water shut off interlock.

4. Oil heater thermostat, with oil temperature interlock.

5. Furnace draft or pressure interlock to ensure adequate damper opening.

Control circuit wiring should be 120 volt to comply with existing building codes and standards.

Sequential Control Timing

1. Cold Start Sequence

   a. Outlet damper opens enough to assure adequate draft to purge furnace.

   b. Fan on to pre-purge furnace.

   c. Spark on, pilot valve open after 15 seconds minimum delay for purging.

   d. Main fuel valve opens to low flame setting after pilot is proven.

   e. Spark off, pilot valve closed after 60 second maximum delay to ensure ignition.

   f. High-low or modulating control may go to high flame or load demand position at normal control motor speed.

   g. Secondary air supply modulated to maintain desired fuel-air ratio.

   h. Outlet damper modulated as required.

2. Normal Load Sequence

   a. Main fuel valve, secondary air supply and furnace draft are modulated to maintain boiler output and optimum fuel-air ratio.

3. Shut-Down Sequence

   a. Main fuel valve closes to low fire, then shuts off completely.

   b. Fan off after 15-second delay to post-purge furnace and reduce oil spillage.

   c. Outlet damper closes.

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

### BURNER CONTROLS

1. Bi-metal elements are available in various sizes and shapes that move when _____ is applied and return to their original _____ when cooled.
2. A mercury tube functions as a simple _____ that can be made to work automatically.
3. A _____ _____ switch is mounted at each entrance to the boiler room and used in case of emergency.
4. In a low water cut-off, a _____ drops when the boiler water is too low.
5. A pressure control starts and stops the burner according to boiler _____.
6. A hand reset pressure control must be _____ manually in case of excess boiler pressure.
7. A cold oil interlock will prevent or stop the burner from operating when the oil is _____.
8. The magnetic oil valve _____ and _____ the flow of oil to the atomizer.
9. The oil temperature control in the electric heater, mounted under or near the burner, controls the oil _____.
10. An air flow switch mounted on the fan casing will keep the magnetic oil valve _____ if the fan is not running.
11. The ignition assembly consists of a transformer, a _____ _____ valve, and electrodes.

12. Residual oil is ignited by a _____ flame.

13. A combustion sensing device, such as a lead sulfide cell, will close the magnetic oil valve if it does not see a flame in approximately _____ to _____ seconds.

14. Electronic tubes in a master controller should be changed _____.

15. Relay contacts may be cleaned by using a _____ card.

16. Testing a low water cut-off control should be done by lowering the boiler water level _____ instead of flushing the control through its drain valve.

17. The fresh air louvre must not be _____ if the boiler room gets too cold.

18. A master controller contains a timer that programs the _____ of the burner.

19. A modulator does not stop the flow of _____ to the spinning cup or atomizer.

20. When a burner is swung open for cleaning, the electric circuit is _____ because a short cable plug or push button switch opens.

## LESSON FIVE

## MAINTENANCE

While the basics of oil burner operation can be spelled out in a course such as this, there are many facets which can be learned only by practical operating experience. Each operator must develop a "feel" for his equipment, getting to know its needs and capabilities by thoughtful daily attention. Learning the art of operation, as well as the science of how the equipment works, can be highly satisfying. If you keep this aim in mind, you can find one of the best rewards of a job well done--a reliable, sweet-running plant.

In this lesson we shall discuss the fundamentals of trouble shooting for the causes of poor combustion, and routine maintenance to increase reliability, prevent air pollution and cut fuel waste.

### COMBUSTION AND AIR POLLUTION CONTROL

The most obvious sign of poor combustion is smoke issuing from the chimney. Excessive smoke means incomplete combustion and wasted fuel, rapid deposit of soot on heat absorbing surfaces of the furnace or boiler, higher flue gas temperatures and increased heat loss to the flue. In addition, smoke coming from a stack in excess of that allowed by the Air Pollution Control Code may result in an order to correct the condition, and/or a fine. Repeated violations may result in court injunctions and/or fines up to $2,500 per day. Air Pollution Control inspectors are trained to determine whether the smoke coming from a stack is in violation.

Permanent test devices can be installed to determine the density of smoke being discharged from a chimney. Portable smoke testers and/or visual observation with the aid of a Ringelmann Smoke Chart or other approved scale can also be used. Such smoke test data should be recorded in the permanent boiler room log.

Smoke may be caused by a number of conditions. Smoke from incinerators will be considered in Lesson Six. At this time we shall consider the causes of smoke from an oil burning boiler:

1. Cold oil.
2. Not enough air for combustion.
3. Uneven oil and/or air supply.
4. Dirty boiler tubes, breeching or chimney.
5. Poor mixing of oil and air in the furnace during burning.
6. Overfiring of oil burner (too much fuel).

The operator should check combustion regularly through the

peep holes in the furnace. This can avoid smoke complaints from the neighbors or an inspector. A smoky, dark orange, or a "sparkling" flame means that smoke is issuing from the chimney.

When smoke is noticed, the operator should check the causes listed above and the corrections below, to see if he can make the corrections or whether a service man must be called. Even if smoke detectors are installed, a visual check should be made regularly. It is very helpful and inexpensive to have an arrangement of mirrors so that the operator can see the top of the chimney without leaving his usual working area around the boiler.

Following are items to check when smoke occurs:

Cold Oil

1. Check all oil heaters. Is the oil leaving at the right temperature? If not, adjust the valves on the steam or hot water oil heaters. Check that switches are closed and fuses intact on electric oil heaters.

2. Consider when heaters were last cleaned. Could they be dirty?

3. Was enough time allowed for oil to heat if the burner was just started?

4. Check oil temperature control.

Combustion Air

1. Check outside air supply louvres. Are they open? Are they blocked by anything such as papers, cardboard, etc?

2. In an enclosed boiler room, is the air supply fan running?

3. Are primary and secondary air dampers open?

4. Are channels and floor clean where secondary air enters the furnace?

5. If an induced draft fan is installed, is it running?

6. Are dampers mounted on the breeching in good working order?

Uneven Air or Oil Supply

1. Is oil pressure fluctuating? Check gauges. High or low oil pressure may cause smoke.

2. If pressure is uneven, are oil strainers clean?

3. Is oil from the tank at the right temperature? If it is too cold it may give the pump an erratic suction.

4. Is oil leaving the electric heater at the right temperature? Too high a temperature may cause boiling at the burner and consequent uneven burning.

5. Are oil relief valves operating properly?

6. Check pumps. Is belt slipping? Pump working properly?

Dirty Tubes, Breeching or Chimney

1. Are tubes, breeching and chimney clean? If not, draft and air supply can be reduced, causing smoke. Soot build-ups may cause "puffs" of smoke or acid smut. Carbon in soot may start to burn, causing dense smoke. Clean tubes, breeching and chimney regularly.

Poor Mixing of Oil and Air in Furnace During Burning

1. Is cup dirty, damaged or loose? If so, clean, replace or tighten.

2. Are venturi blocks and air nozzles dirty or carbonized?

3. Does oil spray strike the furnace walls or floor? Realignment of the burner may be required.

In case of doubt, have a qualified service company make the repairs.

Overfiring of Burner

1. Has orifice setting of the oil control valve been changed to raise steam faster? Your service man sets this at the best opening to raise maximum steam without a smoky fire. Increasing the opening will put more oil in the furnace than it can handle. This will cause smoke.

COMBUSTION EFFICIENCY

A clear flame does not mean an efficient flame. Excess air will usually provide a clear flame, but it will waste fuel and decrease combustion efficiency. The excess air is heated, and some of this heat is carried to the flue where it is wasted. Thus, you need to supply enough excess air to permit clean combustion, without adding so much that combustion efficiency is excessively decreased.

The volume of excess air can be measured indirectly by checking the percentage of carbon dioxide in the flue gases. For any given fuel, the theoretical maximum percentage of $CO_2$ is produced when exactly enough air is supplied to burn the fuel, with no excess whatsoever. Excess air dilutes the stack gases, decreasing the percentage of $CO_2$. Measuring the percentage of $CO_2$ is thus a method of measuring excess air.

Assuming complete combustion, the combustion efficiency can be calculated from the percentage of $CO_2$ and the temperature of the combustion products. Two simple instruments are required.

The first instrument necessary for an efficiency reading is a $CO_2$ indicator or flue gas analyzer. There are several simple and reasonably priced models available. The flue gas sample should be taken from a point in the breeching as close to the last pass of the boiler as possible.

The other instrument required is a flue gas thermometer. Often, a thermometer is permanently installed at a point where the flue gas leaves the boiler to enter the breeching. Under usual conditions, the temperature of the flue gas should be about 125° F above that of the steam. A boiler operating at 5 psi would have steam at about 230° F. Therefore, in an efficient plant, the flue gas should be about 350° F. Since every boiler installation is different, this figure will vary. The flue gas temperature will also indicate when the tubes need cleaning. If the reading is noted when the tubes are clean, an increase above that temperature will indicate a need to clean the tubes. If there is no permanently installed thermometer, a portable one can be inserted through a bolt hole in the breeching or a hole drilled for that purpose. Both the temperature reading and the gas sample can be taken through the same opening.

Use the tables that follow to figure your combustion efficiency and estimated savings when efficiency is increased.

NOTE:

Flue gas temperature indicated on the chart is the difference between actual flue gas temperature and boiler room temperature. Air/oil settings on the burner are apt to change due to vibration. Failure to replace the linkage to its original position after cleaning the cup will also affect the air/oil ratio. The $CO_2$ and the flue gas temperature should be checked at regular intervals by you and your serviceman. A good $CO_2$ reading not only reduces air pollution, but cuts fuel costs as well. (See following page).

## COMBUSTION EFFICIENCY OF AN OIL FIRED PLANT

| Flue Gas Temperature | Percentage of $CO_2$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 550° | 71 | 73 | 75 | 77 | 78 | 79 | 80 |
| 500 | 73 | 75 | 77 | 78 | 80 | 81 | 82 |
| 450 | 75 | 77 | 79 | 80 | 81 | 82 | 83 |
| 400 | 77 | 79 | 80 | 82 | 83 | 83 | 84 |
| 350 | 79 | 81 | 82 | 83 | 84 | 85 | 85 |
| 300 | 81 | 83 | 84 | 85 | 85 | 86 | 87 |

Efficiency in Percent

## SAVINGS FOR EVERY $100 FUEL COSTS BY INCREASE OF COMBUSTION EFFICIENCY

| From an Original Eff. of: | to an Increased Combus ion Efficiency of: 55% | 60% | 65% | 70% | 75% | 80% | 85% | 90% | 95% |
|---|---|---|---|---|---|---|---|---|---|
| 50% | $9.10 | 16.70 | 23.10 | 28.60 | 33.30 | 37.50 | 41.20 | 44.40 | 47.40 |
| 55% | -- | 8.30 | 15.40 | 21.50 | 26.70 | 31.20 | 35.30 | 38.90 | 42.10 |
| 60% | -- | -- | 7.70 | 14.30 | 20.00 | 25.00 | 29.40 | 33.30 | 37.80 |
| 65% | -- | -- | -- | 7.10 | 13.30 | 18.80 | 23.50 | 27.80 | 31.60 |
| 70% | -- | -- | -- | -- | 6.70 | 12.50 | 17.60 | 22.20 | 26.30 |
| 75% | -- | -- | -- | -- | -- | 6.30 | 11.80 | 16.70 | 21.10 |
| 80% | -- | -- | -- | -- | -- | -- | 5.90 | 11.10 | 15.80 |
| 85% | -- | -- | -- | -- | -- | -- | -- | 5.60 | 10.40 |
| 90% | -- | -- | -- | -- | -- | -- | -- | -- | 5.30 |

ROUTINE MAINTENANCE OF AN OIL BURNING PLANT

A regular routine for the maintenance of an oil burning plant will help to prevent air pollution and fuel waste. A regular routine will also increase the reliability of the plant.

Daily

1. Check for oil leaks and/or deposits in furnace.

2. If the plant is shut down, always allow sufficient time for start-up.

3. Check water level in the boiler before closing the burner switch; blow down the low-water cut-off.

4. After the burner has started, check the flame shape and color through the peep hole.

5. When the boiler has reached operating pressure, check fuel oil temperatures and pressures. Keep a daily log.

6. Check flue gas temperatures during operation for any drastic drop or rise in temperature.

If the plant is operated around the clock, shut down some time during the day for routine maintenance. If the plant is shut down at night, perform the following routine maintenance after shutdown:

1. Shut down burner, mark linkage for settings and swing out. Close burner opening in boiler front with plug or cover plate. This will prevent cold drafts from damaging brickwork.

2. Thoroughly clean the air nozzle and oil rotary cup or atomizer with kerosene and a rag. The oil cup must never be scraped with metal tools or abrasives. If necessary, hard carbon may be scraped off with a piece of wood or plastic.

3. Wipe down the entire burner to remove dust and oil.

4. Check oil levels in burner gear case and motor bearings.

5. Check level in fuel oil tanks. Do not depend on "automatic delivery."

6. Clean smoke indicator glasses or lens and peep hole glasses. Test the smoke alarm by placing a cardboard, special test card or screen in front of the light cell.

Weekly

1. Clean both suction and discharge strainers in the oil lines. With some oils, the strainers may have to be cleaned more often.

2. Clean the boiler room and all equipment. Dust and dirt can cause trouble with oil burning equipment. Lint and dust may clog air passages in the burner. They may also ground out electrical connections, particularly if the dirt is oily.

3. During periods of heavy firing, as in the cold winter months, check tubes weekly to see if they need to be cleaned. Follow procedure described under the monthly program.

4. If the boiler chimney is equipped with a spark arrestor, check to see that it is clean.

5. Flush out the water side of oil preheaters.

Monthly

1. Clean fireside of boiler tubes or fireside of sections in a cast iron boiler. Before starting to clean the tubes, be sure that the main switch for the oil burner is open so that the burner cannot start. On boilers where the tube doors or clean out doors are directly above the burner, cover the burner with a piece of canvas or heavy cloth before beginning to clean. This will prevent soot from getting into the air passages and electrical connections on the burner. Make sure there is no draft on the boiler. A draft would pull soot into the breeching and stack where it is harder to remove. This soot may also cause fire in the breeching or be discharged into the atmosphere, causing pollution.

   If possible, allow the boiler to cool before cleaning the tubes to avoid sparks in the soot. A wire brush attached to a vacuum lance is best for actually brushing the firesides of the tubes or sections. Place the soot into cans lined with plastic or paper bags. These liners will prevent the soot from flying around when it is put out for the rubbish collector. Make sure that the necks of the plastic bags are tied. The liners will help to keep your boiler room and sidewalk clean.

   After the burner is placed back in service, check that the tube doors and clean out plates are closed

tightly. All dust and soot on equipment, walls and piping must be cleaned up immediately after the tubes are cleaned. Cleaning the fireside of the boiler in a careless manner can increase your work, contaminate the air and damage equipment.

2. Test all protective equipment and safety devices:

   a. Test remote emergency shut-off switch.

   b. Raise boiler safety valves by hand while steam pressure is on the boiler.

   c. Test low-water cut-off by slowly lowering the water level in the float chamber.

Annually

The burner and boiler should be inspected, cleaned and overhauled at least once a year. The best time for the annual inspection is during the spring, so that if extensive repairs are necessary, they can be done during warm weather months.

1. Have burner inspected and checked by a competent burner mechanic.

2. Drain gear case of burner, then flush and refill with new oil.

3. Check belts on pumps, fans and burner for wear and condition.

4. Replace all vacuum tubes in the oil burner programmer (master controller), smoke detection and other control devices, regardless of condition.

5. Check furnace refractories and burner throat; repair if necessary.

6. Remove all soot from breeching between boiler and stack, and from the base of the stack.

7. Visually inspect the inside of the chimney through the cleanout door at the bottom. Be certain that brick or steel work have not collapsed.

8. Check fuel tank for water or sludge at the bottom. If an appreciable amount is present, have it removed.

9. Check fuel oil gauge accuracy by means of a dip stick or sounding tape.

SAMPLE

BOILER ROOM LOG

Month_____ Year_____

| | 1 | 2 | 3 | . . . . . | 31 |
|---|---|---|---|---|---|
| 1. Boiler water level | | | | | |
| 2. Fuel oil tank levels | | | | | |
| Tank (A) | | | | | |
| Tank (B) | | | | | |
| 3. Suction gauge readings | | | | | |
| 4. Fuel oil tank temperature | | | | | |
| 5. Oil circulation pressure | | | | | |
| 6. Oil firing temperature | | | | | |
| 7. Flue gas temperature | | | | | |
| 8. Draft readings | | | | | |
| 9. Smoke alarm checked | | | | | |
| 10. $CO_2$ reading | | | | | |
| 11. Safety check | | | | | |
| A) Low water cut-off | | | | | |
| B) Remote control | | | | | |
| C) Low draft | | | | | |
| D) Hand reset pressure control | | | | | |
| E) Smoke cut out | | | | | |
| F) Flame failure | | | | | |
| 12. Other | | | | | |

REMARKS:

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

### MAINTENANCE

1. The most obvious sign of air pollution is_____ issuing from a_____.
2. Smoke from an oil burning boiler may be caused by:
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
3. The operator should not wait for complaints from the neighbors before checking for a_____condition.
4. If smoke is issuing from the chimney, the flame will probably be_____ _____in color.
5. In winter, even though the boiler room may be cold, the air supply should not be_____.
6. Uneven oil pressure may be caused by dirty_____.
7. A dirty or damaged oil cup may cause_____.
8. After the oil control valve has been set by the serviceman, for proper oil supply, it should not be_____to raise steam faster.
9. Flue gas temperature should be about_____° F above steam temperature.
10. An increase in flue gas temperature will give you an indication that the _____need_____.

11. To check for efficiency, the $CO_2$ in the flue gas is measured and the_____of the flue gas is taken.

12. As the $CO_2$ percentage in the flue gas increases and the temperature of the flue gas decreases, the combustion efficiency of the boiler will_____.

13. An increase in $CO_2$ percentage not only reduces air contamination but also reduces fuel_____.

14. The oil atomizing cup should be cleaned every_____.

15. A scraper made from_____should be used to remove hard carbon from the oil cup if the kerosene will not dissolve the deposit.

16. Fuel oil strainers should be cleaned at least_____.

17. Safety and protective devices on the boiler and burner should be tested at least_____.

18. Vacuum tubes in control equipment on an oil burner must be replaced every_____.

19. The breeching and chimney should be cleaned and inspected _____or more often if necessary.

20. Cans containing soot and fly ash should be lined with plastic to prevent_____.

## LESSON SIX

## INCINERATORS

It is estimated that five pounds of refuse is generated each day for each person living in the United States. Thus, for every 100 residents it is necessary to dispose of 500 pounds of garbage and rubbish per day -- over 91 tons per year! When incineration is the method of disposal, both the incinerator itself and the emissions from the incinerator stack must be carefully controlled to keep down air pollution. Chapter 11 of the New Jersey Air Pollution Control Code spells out performance standards for incinerators in the state.

In the past, incineration was looked upon as a necessary evil to dispose of trash quickly and cheaply. Industrial and commercial installations used box-like, single-chamber incinerators. Garbage and rubbish from apartment houses was burned in flue-fed, single-chamber incinerators. Homeowners disposed of burnable refuse in backyard trash burners.

While the single-chamber incinerator reduced the volume of refuse to a smaller quantity of more easily disposable ash, the emissions of particulate matter, smoke, unburned waste and ash and odors into the surrounding atmosphere were largely uncontrolled. Present standards require multiple chamber (or equally effective) incinerators that are expected to burn rubbish with a minimum discharge of air contaminants. These incinerators must meet the standards listed in Chapter 11 of the Air Pollution Control Code, regardless of the type of waste being burned. New incinerators may not be of the single flue fed type.

### COMBUSTION

Elimination of offensive emissions (smoke, fly ash, particulates and gases) from incinerators must start with the proper charge to the combustion chamber (furnace). The incinerator must not be overloaded, or expected to burn materials it was not designed to consume.

Assuming suitable material has been put into the combustion chamber, the following "three T's of combustion" are required: adequate time for combustion, adequate turbulence to ensure complete mixing of combustible matter and air, and the necessary temperature to complete the chemical reactions involved.

These "three T's" apply to incineration as well as to the burning of any other fuel. Correct combustion chamber design, good operation and adequate combustion air are as necessary for the proper burning of refuse as for the combustion of oil in an oil

burner, gas in a gas burner, or coal in a coal-fired unit. In all cases, the aim of proper combustion is complete consumption of the fuel, with the production of carbon dioxide and water vapor as the only end products. A close approach to this aim should be your goal in running an efficient incinerator operation.

## TYPES OF INCINERATORS

### Single Flue

In many an older apartment building, the incinerator was nothing more than a refractory chamber with a minimal grate (Figure 6-1). The chamber was located at the base of a charging flue which also served as the chimney for the products of combustion.

In operation, people at the various floors dropped refuse through hopper doors, into the charging flue. Hopefully, at some time during the day before the combustion chamber was filled and refuse began to pile up in the lower portion of the chute, some one started the fire. The gases, odors, pieces of unburned paper and other particulates were carried up the same flue into which the refuse had previously been dropped.

A roof settling chamber was sometimes added to the single-chamber single flue-fed incinerator described above. Hot gases from the incinerator, rising through the flue, entered the settling chamber. The gas velocity was reduced because the cross-sectional area of the settling chamber was several times larger than that of the flue. An obstruction, called a baffle, caused the gas flow to change direction. This change in direction and the slower flow of gases allowed some of the unburned paper and larger particulates to settle out.

A roof settling chamber requires periodic cleaning; however, bad weather and the need to take cans of collected material down from the roof has often led to neglect.

The addition of separate chambers as part of the incinerator construction in the basement helps to minimize the problems of periodic cleaning. This requires installation of a by-pass flue and a charging flue gate. (Figure 6-2). During the burning period the charging flue gate closes off the incinerator from the flue above. The gases from the incinerator furnace exit through an opening called the flame port. A series of separation chambers, as many as four, formed by curtain walls and baffles of refractory construction cause the gases to change direction and velocity. As in the roof chamber, unburned paper and larger particulates settle out. The last chamber leads to a bypass flue which returns the gases to the charging flue eight feet or more above the charging

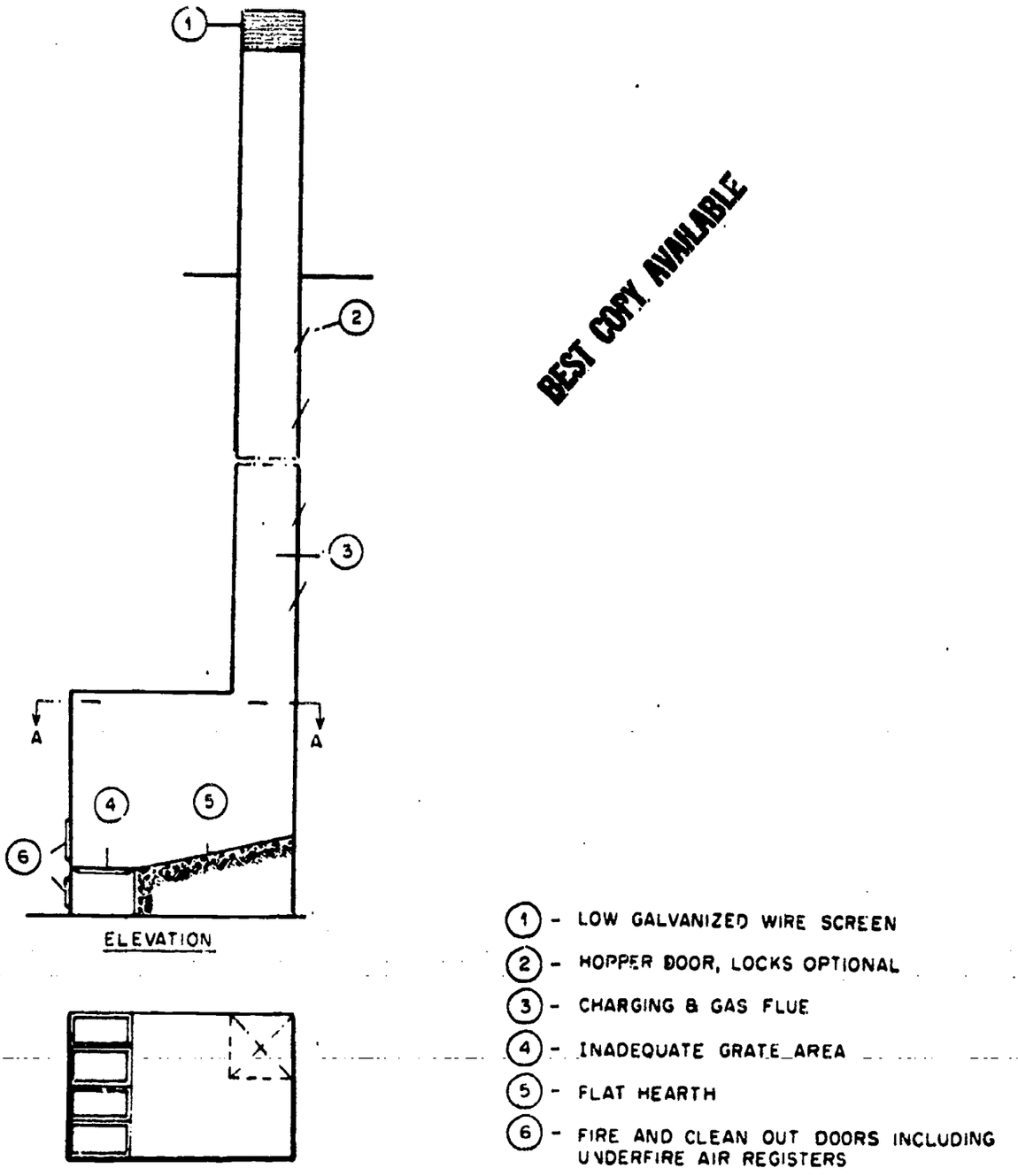
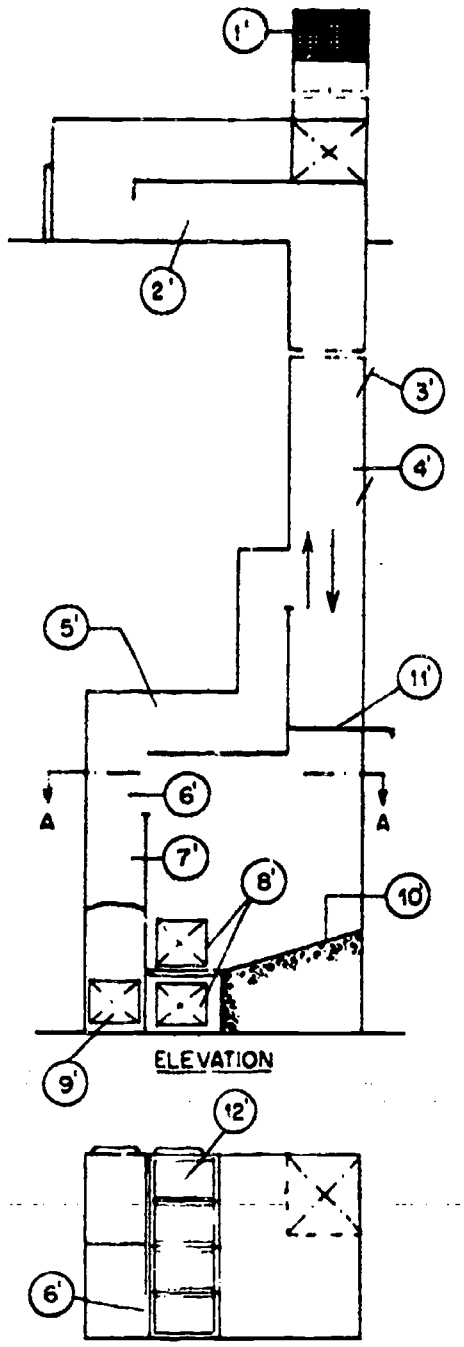





Figure 6-1.

Single flue, single chamber incinerator. Drastic modification would be required for such a unit to meet present emission standards.




(1') - LOW GALVANIZED WIRE SCREEN
(2') - ROOF SETTLING CHAMBER
(3') - HOPPER DOOR-LOCKS OPTIONAL
(4') - CHARGING AND GAS FLUE
(5') - BY-PASS FLUE
(6') - FLAME PORT
(7') - SETTLING CHAMBER
(8') - FIRE AND CLEANOUT DOORS
(9') - CLEANOUT DOOR
(10') - FLAT HEARTH
(11') - CHARGING FLUE GATE
(12') - INADEQUATE GRATE AREA

Figure 6-2.

Single flue, multiple chamber incinerator with bypass flue and roof settling chamber. Installation of auxiliary equipment might permit this unit to meet emission standards.

flue gate. The distance above the charging gate is needed to allow for the accumulation of refuse while burning is going on in the incinerator. Since refuse does not enter the incinerator while burning takes place, the burn can continue more uniformly without outside disruption.

A single-flue incinerator with multiple settling chambers, as described above, would need additional equipment, such as the scrubber and auxiliary gas burner shown in Figure 6-3, to burn refuse and meet the emission standards required by Chapter 11. See section on auxiliary equipment.

Double Flue

Very often, a person opens a hopper door to drop refuse onto the charging gate while a fire is burning in the incinerator combustion chamber. At such times a single-flue unit may send a faceful of hot gas and flyash back through the hopper door. This condition is more likely to occur in a high-rise apartment building where the exhaust ventilating system creates a negative pressure in the halls. Flares of gas and flyash may be prevented by installing automatic hopper door locks. However, this is not always successful and may cause inconvenience to the tenants. The double-flue system was designed to correct this condition.

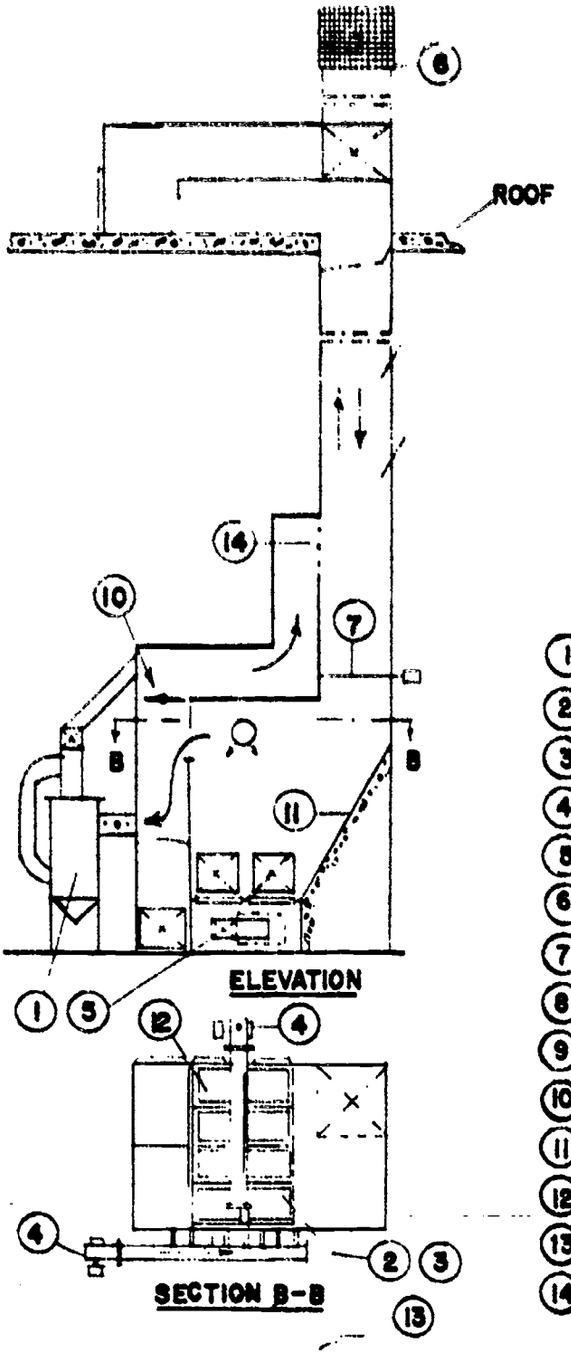
A charging flue is used to drop the refuse into the incinerator. The gases from the fire rise up a separate gas flue. Figure 6-4 shows a double-flue installation with multiple chamber incinerator.

Direct Fed

Establishments such as schools, factories supermarkets and department stores generally do not have flue fed incinerators. They use direct fed units with multiple chambers, charged through a firing door on one of the incinerator walls (Figure 6-5) or through an opening on the top. Specially-designed incinerators are available for burning various types of waste, such as pathological and animal wastes, auto bodies, radioactive wastes, sludge, etc. The incinerator must be matched to the type of refuse for proper performance, and the manufacturer's specific operating instructions for your unit should be carefully followed. However, the general principles of combustion and operation, which are presented in this lesson, are common to all types of refuse burning equipment.

AUXILIARY EQUIPMENT

Control of emissions from an incinerator may require some or all of the following equipment: primary or ignition burner, cycling time clock, secondary or after burner, temperature indicator and controller, overfire air system, flue gas cleaner (usually a scrubber), automatic bypass damper, exhaust or




1. SCRUBBER OR EQUIVALENT AIR CLEANER
2. AUXILIARY GAS BURNER
3. AUTOMATIC FIRING CLOCK
4. OVERFIRE AIR FAN AND NOZZLE SYSTEM - 2 SCHEMES SHOWN
5. UNDERFIRE AIR REGISTERS
6. HIGH STAINLESS STEEL SCREEN
7. CHARGING FLUE GATE - POWER OPERATED
8. AUTOMATIC DRAFT CONTROL FOR SCRUBBER
9. RECIRCULATION SYSTEM WITH MAKE-UP WATER FOR SCRUBBER
10. AUTOMATIC BY-PASS DAMPER
11. STEEP HEARTH
12. ENLARGED GRATE
13. FURNACE TEMPERATURE CONTROL
14. STAINLESS STEEL BARS

Figure 6-3.

Modified single flue, multiple chamber incinerator, with gas burner, scrubber and bypass flue.

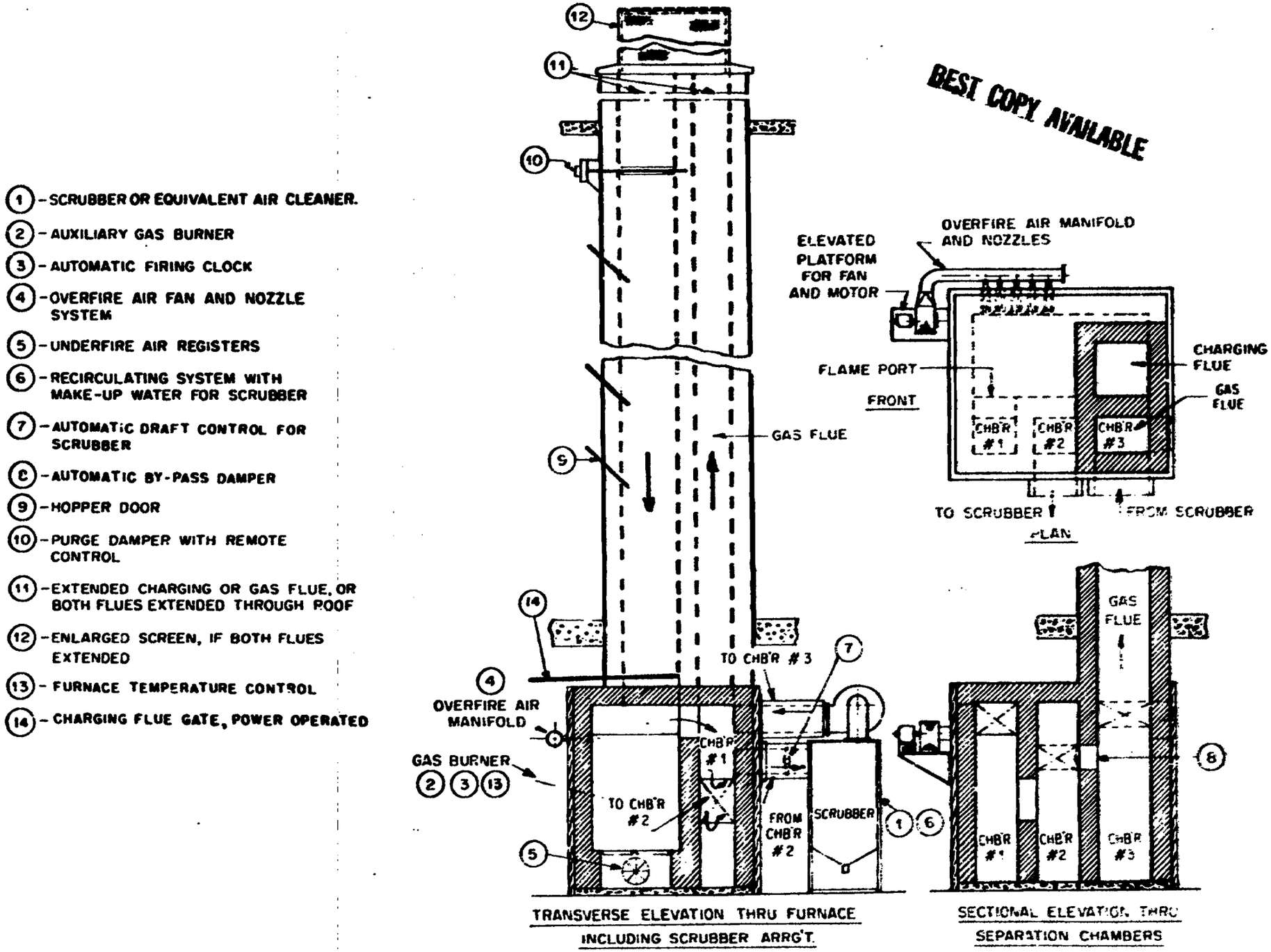
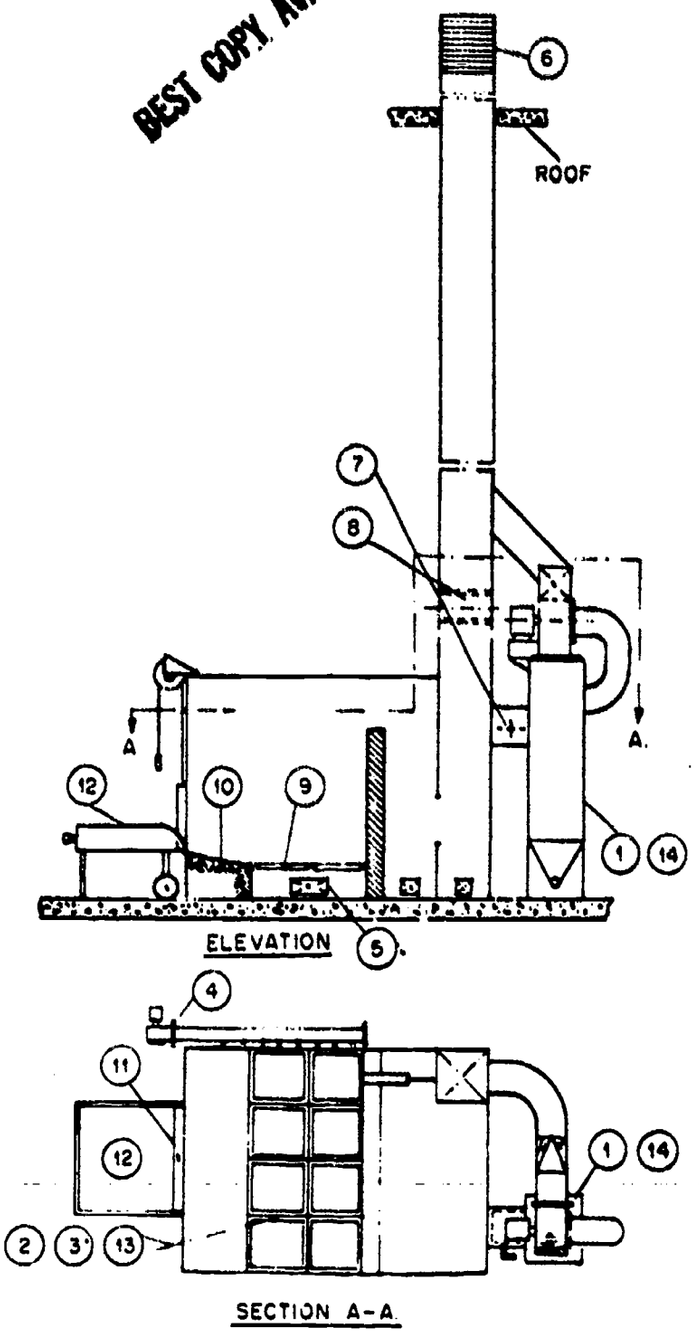



Figure 6-4. Multiple chamber incinerator with double flue and auxiliary equipment.




(1) - SCRUBBER OR EQUIVALENT AIR CLEANER
(2) - AUXILIARY GAS BURNER
(3) - AUTOMATIC FIRING CLOCK OR SUPERVISION OF OPERATOR
(4) - OVERFIRE AIR FAN AND NOZZLE SYSTEM
(5) - UNDERFIRE AIR REGISTERS
(6) - HIGH STAINLESS STEEL SCREEN
(7) - AUTOMATIC DRAFT CONTROL
(8) - AUTOMATIC BY-PASS DAMPER
(9) - LARGE GRATE
(10) - FLAT HEARTH
(11) - GUILLOTINE CHARGING GATE, POWER OPERATED
(12) - CHARGING APRON
(13) - FURNACE TEMPERATURE CONTROL
(14) - RECIRCULATION SYSTEM WITH MAKE-UP WATER FOR SCRUBBER

Figure 6-5. Direct fed incinerator with scrubber.

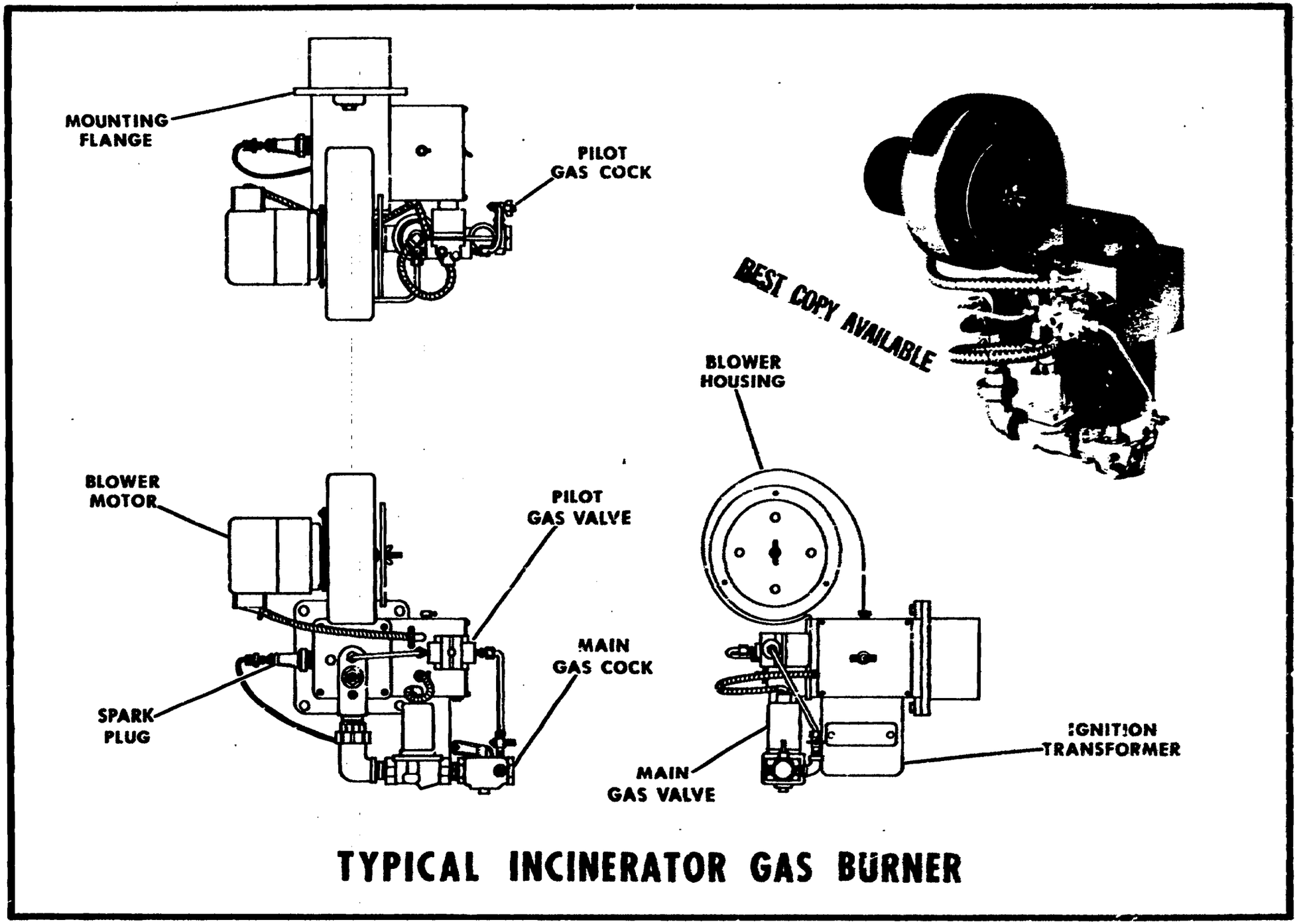

MOUNTING FLANGE
PILOT GAS COCK
BEST COPY AVAILABLE
BLOWER HOUSING
BLOWER MOTOR
PILOT GAS VALVE
MAIN GAS COCK
SPARK PLUG
IGNITION TRANSFORMER
MAIN GAS VALVE
TYPICAL INCINERATOR GAS BURNER

Figure 6-6

induction fan. (Note that the screen or spark arrestor on the top of the flue is not an air pollution control device. The spark arrestor is a safety device, designed to prevent fires caused by the escape of burning particles.)

Obviously, controlling the amount of material to be consumed in any one burn is a vast improvement over just igniting whatever happens to be dropped on the grate before or during the burn. This can be accomplished by installing a primary burner, controlled by a cycling time clock which is set for several burns during the day. The time clock can control the opening and closing of the charging flue gate as well as ignition and shut-off of the primary burner and other auxiliary equipment. The burner bears directly on the refuse, ignites it and provides additional heat during the burning cycle.

A secondary or after burner may be required to keep temperature high enough to insure good combustion and odor elimination, but not so high as to cause excessive maintenance problems with the refractory surface. A temperature indicator and controller, usually a thermostat or pyrometer, maintains the temperature at about 1500° F, igniting the burner when the temperature drops below approximately 1400° F, shutting off burner at higher end of the temperature range, about 1600° F.

Note that the secondary or after burner burns only combustible solids and gases; ash and other incombustibles will go on through the unit and must be removed in the settling chambers or by the flue gas cleaner.

While the gas burner is an aid in maintaining proper incineration temperature, the quantity of excess air has a greater effect on temperature. Actual air requirements are 200% of the theoretical quantities of air calculated for complete combustion. The manner in which this air is distributed in the incinerator has a marked effect on the combustion. An overfire (secondary) air fan system insures adequate air above the grate and provides the necessary turbulence for mixing air and gases. This overfire air fan system provides a fixed quantity of the air requirements throughout the burning cycle. The actual quantity is 25% to 50% of the total maximum air requirements. Primary air is furnished from below the grates (under fire air) and through and around charging doors.

The overfire air fan system is usually one of two designs. In one, a pipe with a series of holes drilled along its length is placed through and into the incinerator. The pipe size, length and number of holes and their spacing are determined by the specific incinerator in question. An air fan (blower) with a damper arrangement that can be locked in a set position completes the system. The other design employs a similar piece of

pipe as an external manifold. From this a series of smaller pipes passes through the refractory walls and furnishes the required overfire air. As with the previous design a blower with damper is required.

No matter how efficient the combustion, there will be emissions from the incinerator. These remaining emissions require the installation of control devices to limit them. A flue gas scrubber is the usual choice.

The term scrubber covers a broad group of control devices which use water or other fluids to remove materials from a gas stream. The simplest type of scrubber can be just a water curtain. Sprays of water in a settling or separation chamber are not acceptable as a scrubber. A true venturi type scrubber draws water and the gases through narrow venturi sections at high velocities. Other scrubbers use a cascade effect, centrifugal force, impingement, etc., to accomplish the necessary reduction in particulates.

Scrubbers remove both particulates and obnoxious gases, making them very desirable collection devices. However, they may require high power consumption to attain high collection efficiency. In addition, the operator must guard against the scrubber burning out. Even a refractory lined scrubber may burn out, requiring expensive repairs or replacement, if the water freezes, if water is inadvertently turned off, or if the spray nozzles are clogged.

Figure 6-7 through 6-10 illustrate several commercially available scrubbers.

The installation of a scrubber or other air cleaning device requires an exhaust or induction fan to remove the final gaseous products. An automatic furnace draft controller varies the amount of gases drawn through the system. When the burning rate is rapid, more gases are generated in the combustion chamber. The damper opens wider to maintain a preset draft condition of approximately 0.10 to 0.15 inches water gauge in the combustion chamber. As the refuse is consumed, less gases are generated. The damper closes to limit the draft available within the combustion chamber, otherwise fly ash could be lifted off the grates. If excess air were not controlled, it could chill the fire and create smoke. However, the incinerator room must always have enough air to supply the combustion needs.

Sufficient air supply into the incinerator room avoids the alternate smouldering and uncontrolled burning caused by inadequate ventilation. A fixed louvre in an exterior wall, or an air duct from the outside, is necessary. Under some conditions, a fan interlocked with the incinerator operation may be necessary to ensure an adequate air supply.

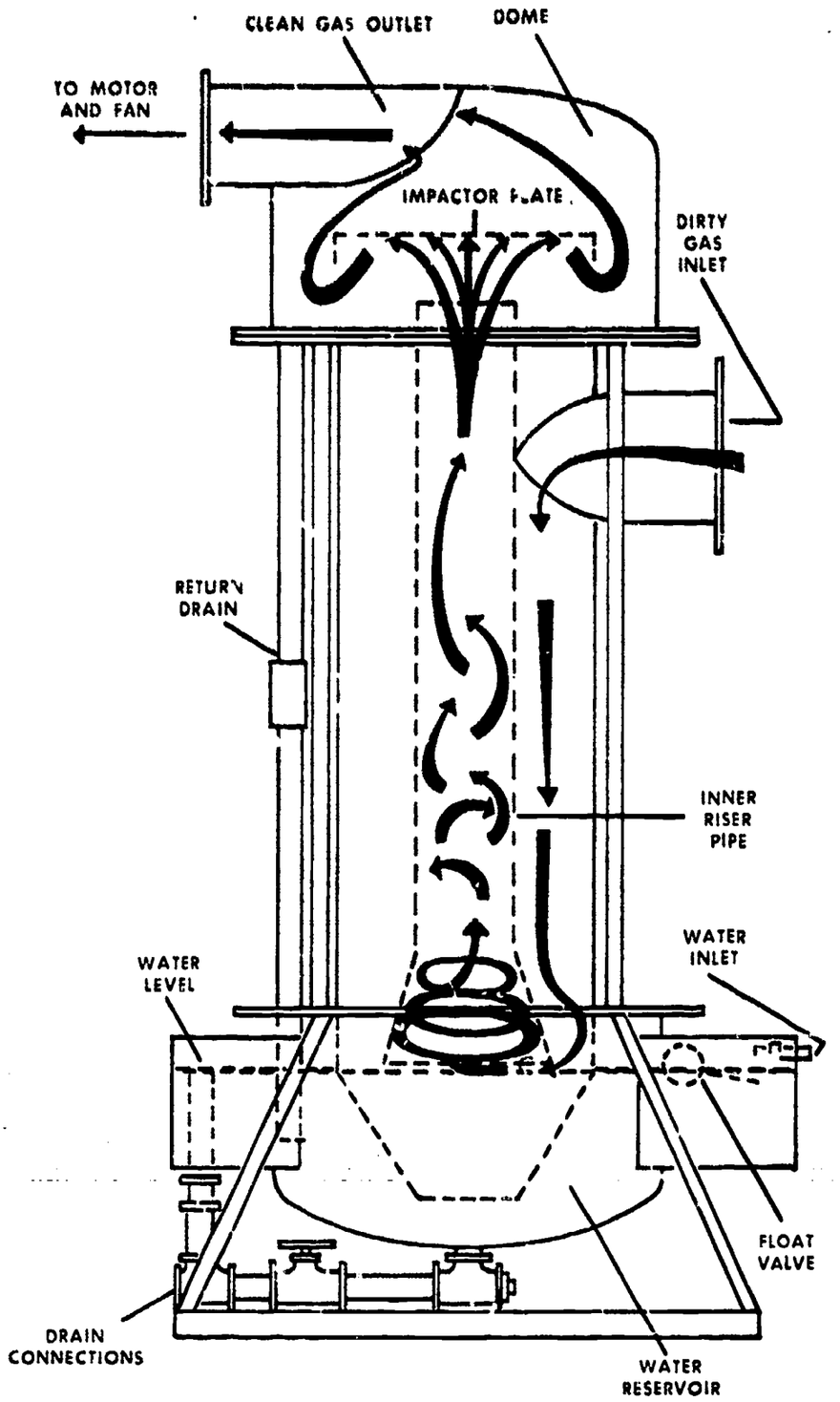



Figure 6-7. Impingement-type scrubber.

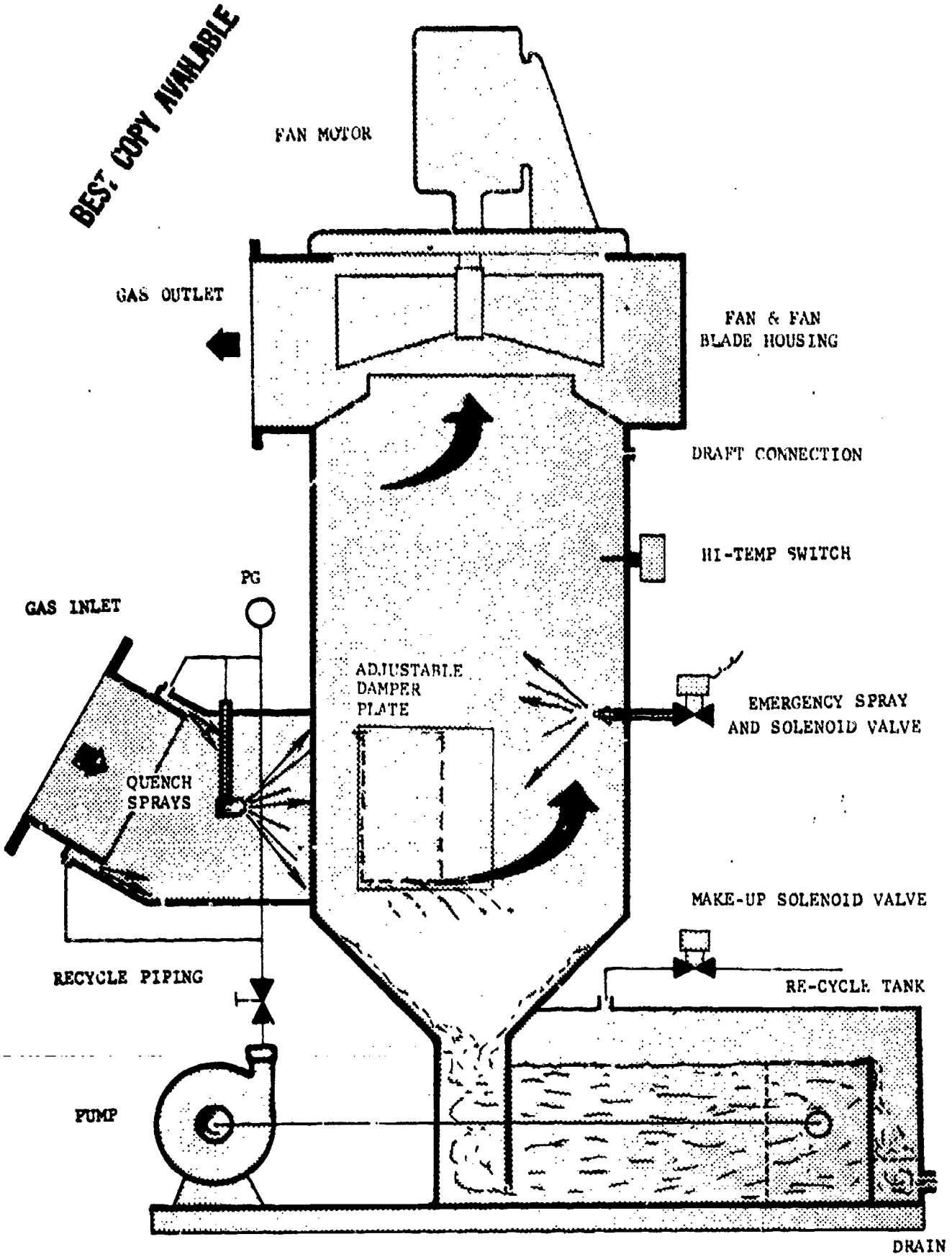



Figure 6-8. Centrifugal-type scrubber.

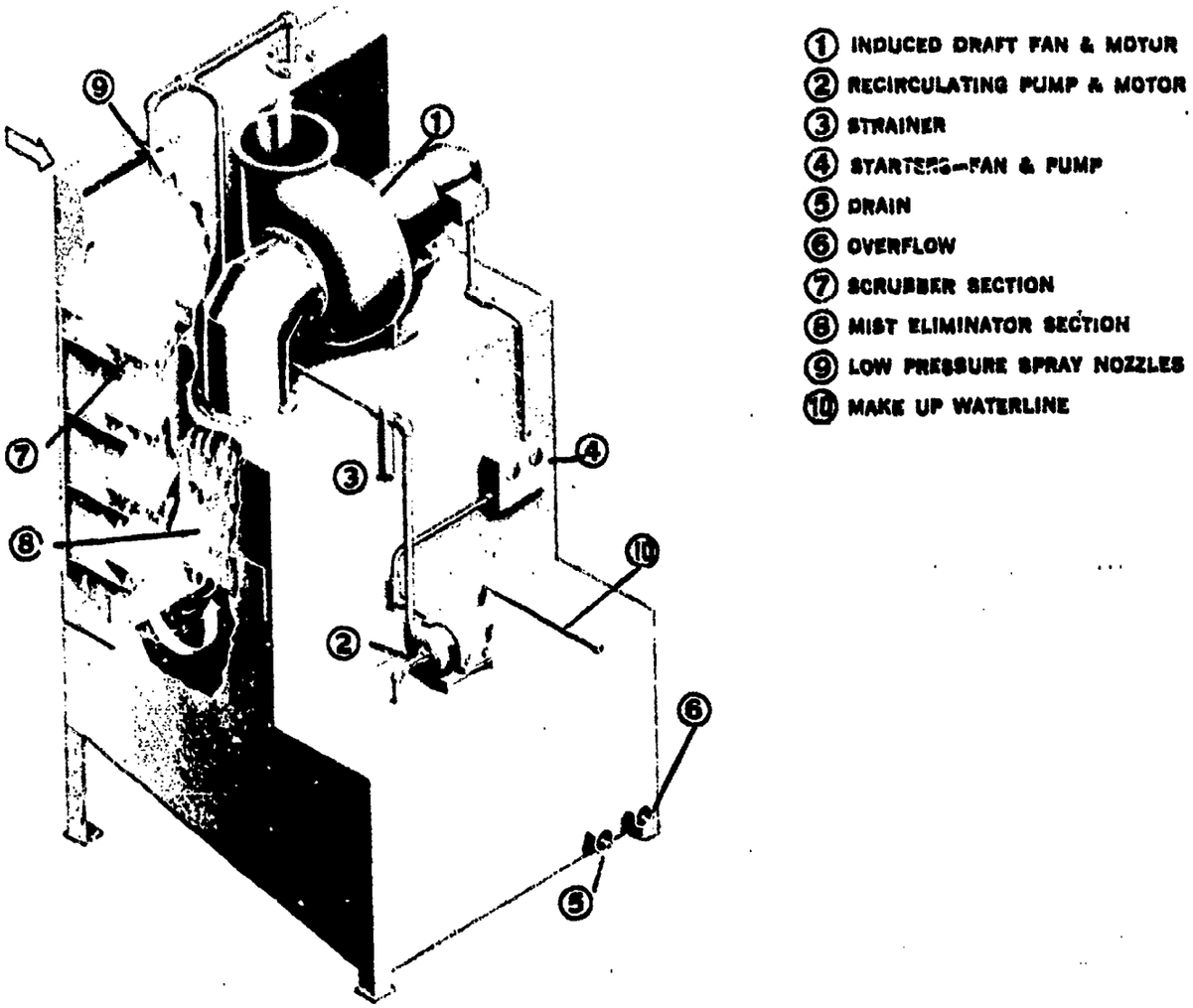



Figure 6-9. Cascade-type scrubber.

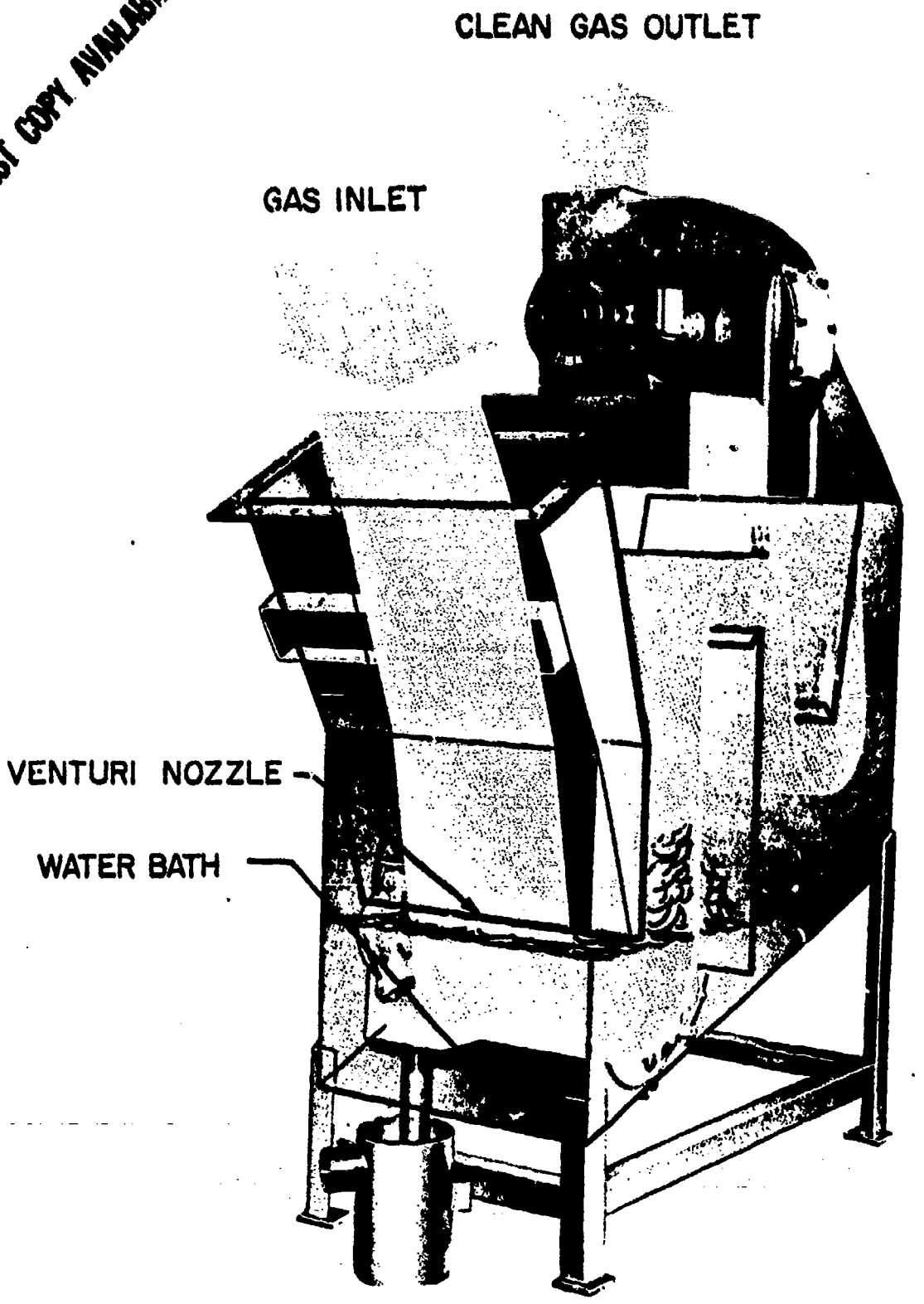



Figure 6-10. Modified venturi-type scrubber.

An automatic bypass damper serves the dual purpose of venting the combustion gases up the flue and protecting the scrubber in the event of faulty operation at the scrubber during a burn. The bypass damper usually is operated by an air flow switch and a high temperature cut-out switch in the scrubber flue outlet. An excessive rise in temperature or a reduction in the flow of gases through the scrubber will automatically operate the flue bypass damper to vent the gases directly up the flue.

This damper is to be used only in case of emergency shut-down of the scrubber during a burn. Operation of an incinerator without all control apparatus functioning properly and in use is illegal.

CHARGING A FLUE-FED INCINERATOR

Apartment house tenants have a tendency to throw everything possible down the incinerator charging flue. If it were possible, they would even drop pianos or rubber tires into the flue. This happens, even though printed signs posted next to each hopper door advise what must not be thrown down. All buildings should have these signs, which are available from most incinerator dealers.

Cases are recorded where aerosol bombs dropped into the combustion chamber have exploded. In exploding, a can has gone through nine inches of brickwork, across a five foot corridor and partially penetrated into another brick wall. Another exploding aerosol can rose six floors, broke through a spark arrestor, and continued going. Similar cases have resulted in fatal accidents. To help prevent injury to yourself, NEVER OPEN THE COMBUSTION CHAMBER DOOR DURING A BURN. Don't stand in front of the door, even though it is shut.

People living in apartment houses must be educated to the danger of exploding aerosol cans. Signs at every hopper door should remind tenants that newspapers, boxes, clothes hangers, glass, tin cans, etc., should not be thrown into the incinerator. A daily pick-up service should be made available to collect these items. It is well worth the inconvenience of separating the trash for the advantage gained in safer, cleaner incinerator operation.

OPERATING CYCLES

The operating cycles for the three types of incinerators described above vary to some degree. Operation of typical single flue, double flue and direct fed incinerators is as follows:

1. Single Flue, Multiple Chamber with bypass charging

flue gate, scrubber and induced draft fan

a. Burning Cycle (usually controlled by cycling time clock)

(1) Hopper doors lock.

(2) Charging flue gate opens and closes.

(3) Induced draft fan, scrubber and automatic draft controller start; automatic bypass damper closes.

(4) Overfire air fan starts and burner ignites.

(5) Burn continues for preset interval, usually 30 to 60 minutes.

b. At End of Burning Cycle

(1) Burner and overfire air fan stop.

(2) Scrubber stops, induced draft fan stops, automatic draft controller closes, and automatic bypass damper opens.

(3) Hopper doors unlock.

(4) Charging flue gate opens briefly at next time cycle to pass accumulated refuse into combustion chamber. (This gate is normally closed. The incinerator should be charged only at 15 to 30 minute intervals during non-burn periods. The combustion chamber should never be more than half full of refuse.)

(5) Operator removes accumulated residue and siftings from grate and ash pit, at least once each day or more frequently if necessary. CAUTION: To avoid fire, never put hot residue into non-fireproof containers; do not place containers of hot residue near combustible material.

2. Double Flue, Multiple Chamber Incinerator with scrubber and induced draft fan

a. Between Burns

Charging flue gate remains closed except for

opening briefly at 15 to 30 minutes intervals to pass accumulated refuse into combustion chamber. Opening and closing cycle should continue 24 hours a day. Once a day, open the charging flue gate and the purge damper, allowing heat from the burner to escape through the charging flue for perhaps 10 minutes. This removes grease deposited on the charging flue walls, and exterminates vermin. This purging should not be done when refuse is being burned. After the purge, normal cycling resumes.

b. Burning Cycle (usually controlled by cycling time clock)

(1) Charging flue gate opens and closes.

(2) Induced draft fan, scrubber and automatic draft controller start, automatic bypass damper closes.

(3) Overfire air fan starts and burner ignites.

(4) Burn continues for preset period.

c. At End of Burning Cycle

(1) Burner and overfire air fan stop.

(2) Scrubber and induced draft fan stop, automatic draft controller closes, automatic bypass damper opens.

(3) Operator removes accumulated residue at least once a day.

3. Direct Fed Multiple Chamber Incinerator with scrubber, induced draft fan and secondary burner

a. Burning Cycle (cycling time clock optional)

(1) Start induced draft fan, scrubber and automatic draft controller, close automatic bypass damper.

(2) Start overfire air fan.

(3) Start secondary burner to preheat incinerator. Preheat for at least 15 minutes.

(4) Load refuse into combustion chamber at set intervals to avoid excessive pileup in charging chute hopper.

(5) Start primary burner.

(6) Burn down refuse under supervision of operator or under automatic control.

b. At End of Burning Cycle

(1) Stop primary burner.

(2) Stop secondary burner.

(3) Stop overfire air fan.

(4) Stop scrubber and induced draft fan, close automatic draft controller and open automatic bypass damper.

(5) Remove accumulated residue at least once a day.

MAINENTANCE

It is important that routine maintenance be done periodically. The following schedule is suggested for minimum upkeep of equipment:

Daily

1. Remove residue and siftings from grates as well as ash pit.

2. Inspect for proper operation: gas burner and controls; grates; flue gate; overfire air fan system; scrubber and pump; induced draft fan; cycling time clock.

3. Check all cleanout doors.

4. Remove sludge from scrubber sump.

5. Clean strainers in water recirculating line (if included).

Weekly

1. Remove accumulated fly ash from secondary chambers and flues.

2. Inspect hopper doors for tightness of fit.

3. Inspect spark arrestor for cleanliness and repair.

4. Remove accumulated fly ash in secondary chambers.

5. Check and clean spray nozzles and/or water feed line strainer (if included).

6. Inspect refractory and repair or replace defective brick.

NOTE: Report immediately any malfunctioning or deterioration to owner or agent.

GLOSSARY OF INCINERATOR TERMS

Arch Height

The vertical distance, within the combustion chamber, from the top of the grate level to the roof of the chamber.

Baffle

Any refractory or metal construction used to change the direction of flow of the gases.

Bypass Flue

A passage used to carry the gases of combustion from the separation chambers to the charging flue, or to the gas flue.

Charging Flue Gate

A gate that separates the bottom of the charging flue from the combustion chamber. When closed, it prevents refuse from entering the combustion chamber and hot gases from going directly up the charging flue.

Combustion Chamber (Furnace)

A chamber of an incinerator within which refuse is dried or volatilized, ignited and burned.

Curtain Wall

A baffle suspended from the top of the chamber so that gas flows down and under it.

Cycling Time Clock

A clock which controls the operation of equipment necessary for a proper burning cycle.

Draft Controller

An automatic device to maintain a uniform combustion chamber draft by regulation of an internal damper.

Draft and Closed Damper Interlocks

A control which shuts off the gas burner and the overfire air fan if a positive draft occurs in the combustion chamber.

Flame Port

An opening high up on the wall of the furnace through which the combustion gases pass into the first separation chamber.

Grate

The metal surface in the combustion chamber that supports the refuse while it is being burned. The grate area should be 50% of the total burning area where possible. Underfire air passes through to mix with the refuse for proper combustion.

Hearth

That part of the refractory in the combustion chamber on which refuse collects and dries. Hearths under the charging flue should be inclined sufficiently from the horizontal so the refuse will slide on to the grate for efficient burning.

Manual Damper

A metal plate in a flue or duct that may be set by hand to control the flow of gases or air.

Overfire Air

Air brought into the combustion chamber above the refuse bed, with or without a fan, to provide turbulence and assist in the combustion process.

Overfire Air Fan System

A system consisting of an air fan, damper and a manifold with nozzles which supplies controlled air over the grate. This system supplies 25% to 50% of the total air required. The manifold may be located either inside or outside of the combustion chamber.

Purge Damper

A damper used in double flue incinerators to permit cleaning

the charging flue with heat. The damper, located above the top floor hopper door, is opened during the cleaning cycle.

Refuse

A mixture of rubbish and garbage.

Residue

Ashes, incombustible solids and partially burned refuse collected from grates or ash pits.

Scrubbers

A broad group of control devices which use water or other fluids to remove materials from a gas stream.

Scrubber Bypass Damper

A damper normally closed when the scrubber is in use. It opens automatically when the scrubber is shut down or becomes inoperative, permitting gases to go directly to the flue. This damper is to be used only in case of emergency shutdown of the scrubber. Operating an incinerator without all control apparatus is illegal.

Separation Chamber

Any chamber after the furnace, designed to remove fly ash, paper and other coarse matter from the gas stream by changing the direction of flow and reducing the velocity of the gases.

Spark Arrestor

A screen preferably made of stainless steel wire. It is placed on top of the charging and gas flues for fire prevention by keeping the larger sparks and burning material from leaving the flue.

Temperature Control

A control which starts and stops the burner whenever the temperature drops below or reaches the top of the pre-set temperature range during the burn cycle. An indicating pyrometer is generally included.

Underfire Air

Air brought into the bottom of the furnace which passes through the grate and refuse on top of the grate. It helps to control the rate of burning. Of the total air required, probably 50% should be underfire air.

## PROBLEMS FOR FURTHER STUDY AND DISCUSSION

### INCINERATORS

1. The "three T's of combustion" are _____, _____, _____.
2. Emissions from an uncontrolled incinerator may include _____, _____, _____, _____, _____,
3. The secondary burner should operate between about _____° F and _____° F.
4. The overfire air fan should supply _____% to _____% of the total air supply.
5. Between burns, the charging flue gate should remain _____.
6. The spark arrestor is made of _____.
7. An automatic draft controller maintains a pre-set draft condition of approximately 0.10 to 0.15 inches water in the _____.
8. A cycling time clock is used to _____ the operation of equipment.
9. Overfire air is brought into the combustion chamber through a steel pipe called a _____.
10. In the incinerator combustion chamber air is mixed with the burning refuse for _____ _____.
11. A purge damper is located above the highest _____ _____.
12. Refuse is prevented from falling directly into the combustion chamber by the _____ _____.

13. Particulate matter is removed from flue gases by a_____.

14. Signs notifying people what should not be thrown down the incinerator charging flue should be placed at the _____ _____.

15. To dry the garbage and then burn it requires the use of a _____ or _____burner.

16. A smoky fire in an incinerator is usually due to insufficient _____.

17. The incinerator residue should be cleaned out at least every _____.

18. A secondary burner may be required to keep temperature high enough to insure_____ _____ and _____ _____.

19. The opening between the furnace and first separation chamber is called a _____ _____.

20. The draft and closed damper interlocks shut down the_____ if a positive combustion chamber draft exists.

# NEW JERSEY AIR POLLUTION CONTROL LAWS

*Published by the New Jersey State Department of Health, Air Pollution Control Program, John Fitch Plaza, Trenton, N. J. 08625.*

# GENERAL PROVISIONS OF 1954 ACT AS AMENDED

**Including:** Definitions, abolition of Commission, Clean Air Council; rule-making and enforcement powers of the Department; enforcement procedures; penalties; municipal powers.

P. L. 1954, c. 212 (Title 26:2C-1 to 2C-23), amended by P. L. 1962, c. 215; P. L. 1967, c. 105; and P. L. 1967, c. 106

**NOTE:** Other portions of the 1954 Act, as amended, and other air pollution laws are available. They include:

- Emergency Control Act
- Motor Vehicle Law
- Permit for Construction, Installation and Alteration of Equipment
- Air Pollution Scholarship and Intern Program
- Tax Exemption for Air and Water Pollution Control Equipment
- Mid-Atlantic States Air Pollution Control Compact

**An act relating to the control and** suspension of air pollution, creating a Clean Air Council in the State Department of Health and prescribing its functions, powers and duties.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

## 26: 2C-1

This act shall be known and may be cited as the "Air Pollution Control Act (1954)."

## 26: 2C-2

The following words shall have the following meanings:

"Council" means the Clean Air Council created under this act.

"Department" means the State Department of Health.

"Air pollution" as used in this act shall mean the presence in the outdoor atmosphere of one or more air contaminants in such quantities and duration as are, or tend to be, injurious to human health or welfare, animal or plant life or property, or would unreasonably interfere with the enjoyment of life or property throughout the State and in such territories of the State as shall be affected thereby and excludes all aspects of employer-employee relationship as to health and safety hazards.

"Commissioner" means the Commissioner of Health in the State Department of Health.

"Control apparatus" means any device which prevents or controls the emission of any air contaminant.

"Equipment" means any device capable of causing the emission of an air contaminant into the open air, and any stack, conduit, flue, duct, vent or similar device connected or attached to, or serving the equipment. This shall include equipment in which the preponderance of the air contaminant emitted is caused by the manufacturing process.

"Person" means and shall include corporations, companies, associations, societies, firms, partnerships and joint stock companies as well as individuals, and shall also include all political subdivisions of this State or any agencies or instrumentalities thereof.

(Sections 3 through 7 repealed by P. L. 1967, c. 106, Section 16.)

## 26: 2C-3.1

The Air Pollution Control Commission is hereby abolished. All of the functions, powers and duties of the Air Pollution Control Commission in the Department of Health are hereby transferred to the Department of Health.

## 26: 2C-3.2

(a) There is hereby created in the State Department of Health a Clean Air Council, which shall consist of 17 members, 3 of whom shall be the Commissioner of Labor and Industry or a member of the Department of Labor and Industry designated by him, the Commissioner of Community Affairs or a member of the Department of Community Affairs designated by him, and the Secretary of Agriculture or a member of the Department of Agriculture designated by him, who shall serve ex officio, 6 citizens of the State representing the general public at least one of whom shall be a medical doctor licensed to practice in this State and 8 members to be appointed from persons to be nominated by the organizations hereinafter enumerated, by the Governor.

(b) Within 30 days following the effective date hereof and thereafter as required, at least 1 month prior to the expiration of the term of the member chosen from nominees of each organization hereafter enumerated, each such organization shall submit to the Governor a list of 3 recommended nominees for membership on the council from which list the Governor shall appoint one.

If any organization does not submit a list of recommended nominees at any time required by this act, the Governor may appoint a member of his choice.

The organizations which shall be entitled to submit recommended nominees are: New Jersey Health Officers Association, New Jersey State Chamber of Commerce, New Jersey Society of Professional Engineers, Inc., New Jersey Manufacturers Association, New Jersey Section of the American Industrial Hygiene Association, New Jersey State League of Municipalities, the New Jersey Freeholders' Association and the New Jersey State AFL-CIO.

(c) Of the 12 members first to be appointed, 3 shall be appointed for terms of 1 year, 3 for terms of 2 years, 3 for terms of 3 years and 3 for terms of 4 years. Thereafter, all appointments shall be made for terms of 4 years. All appointed members shall serve after the expiration of their terms until their respective successors are appointed and shall qualify, and any vacancy occurring in the appointed membership of the council by expiration of term or otherwise, shall be filled in the same manner as the original appointment for the unexpired term only, notwithstanding that the previous incumbent may have held over and continued in office as aforesaid. The Governor may remove any appointed member of the council for cause after a public hearing.

(d) Members of the council shall serve without compensation but shall be reimbursed for expenses actually incurred in attending meetings of the council and in the performance of their duties as members thereof.

(e) The council shall elect annually a chairman and vice-chairman from its own membership.

## 26: 2C-3.3

The Clean Air Council shall:

(a) Request from the commissioner information concerning the Air Pollution Control Program;

(b) Consider any matter relating to the preservation and improvement of the Air Pollution Control Program and advise the commissioner thereon;

(c) From time to time submit to the commissioner any recommendations which it deems necessary for the proper conduct and improvement of the Air Pollution Control Program;

(d) Study the Air Pollution Control Program and make its recommendations thereon to the commissioner;

(e) Study the codes, rules and regulations promulgated by the department in regard to air pollution control and make its recommendations for their improvement to the commissioner;

(f) Study and investigate the state of the art and the technical capabilities and limitations of air pollution control and report their findings and recommendations thereon to the commissioner;

(g) Study and investigate the need for programs for the long-range technical support of the Air Pollution Control Program and report their findings and recommendations thereon to the commissioner; and

(h) Hold public hearings at least once a year in regard to existing air pollution control, statutes, codes, rules and regulations and upon the state of the art and technical capabilities and limitations in air pollution control and report its recommendations thereon to the commissioner.

## 26: 2C-8

The department shall have power to formulate and promulgate, amend and repeal codes and rules and regulations preventing, controlling and prohibiting air pollution throughout the State or in such territories of the State as shall be affected thereby; provided, however, that no such code, rule or regulation and no such amendment or repeal shall be adopted except after public hearing to be held after 30 days prior notice thereof by public advertisement of the date, time and place of such hearing, at which opportunity to be heard by the department with respect thereto shall be given to the public; and provided, further, that no such code, rule or regulation and no such amendment or repeal shall be or become effective until 60 days after the adoption thereof as aforesaid. Any person heard at such public hearing shall be given written notice of the determination of the department.

All codes, rules and regulations heretofore adopted by the Air Pollution Control Commission shall continue in full force and effect subject to the power of the department to amend and repeal such codes, rules and regulations as provided by this act.

**(see footnote)**

## 26: 2C-9

The department shall control air pollution in accordance with the provisions of any applicable code, rule or regulation promulgated by the department and for this purpose shall have power to—

(a) Conduct and supervise research programs for the purpose of determining the causes, effects and hazards of air pollution;

(b) Conduct and supervise State-wide programs of air pollution control education including the preparation and distribution of information relating to air pollution control;

(c) Require the registration of persons engaged in operations which may result in air pollution and the filing of reports by them containing information relating to location, size of outlet, height of outlet, rate and period of emission and composition of effluent, and such other information as the department shall prescribe to be filed relative to air pollution, all in accordance with applicable codes, rules or regulations established by the department. Registration reports filed with the department shall be privileged and not admissible in evidence in any court;

(d) Enter and inspect any building or place, except private residences, for the purpose of investigating an actual or suspected source of air pollution and ascertaining compliance or noncompliance with any code, rules and regulations of the department. Any information relating to secret processes or methods of manufacture or production obtained in the course of such inspection, investigation or determination, shall be kept confidential and shall not be admissible in evidence in any court or in any other proceeding except before the department as herein defined. If samples are taken for analysis, a duplicate of the analytical report shall be furnished promptly to the person suspected of causing air pollution;

(e) Receive or initiate complaints of air pollution, hold hearings in connection with air pollution and institute legal proceedings for the prevention of air pollution and for the recovery of penalties, in accordance with this act;

(f) With the approval of the Governor, cooperate with, and receive money from, the Federal Government, the State Government, or any county or municipal government or from private sources for the study and control of air pollution.

## 26: 2C-9.1

No person shall obstruct, hinder or delay, or interfere with by force or otherwise, the performance by the department or its personnel of any duty under the provisions of this act, or of the act of which this act is amendatory and supplementary, or refuse to permit such personnel to perform their duties by refusing them, upon proper identification or presentation of a written order of the department, entrance to any premises at reasonable hours.

(see footnote)

(Section 10 repealed by P. L. 1962, C.215. Sections 11 through 13 repealed by P. L. 1967, c.106, Section 16.)

## 26: 2C-14

Whenever the department has cause to believe that any person is violating any code, rule or regulation promulgated by the department, the department shall cause a prompt investigation to be made in connection therewith.

If upon inspection the department discovers a condition which is in violation of the provisions of this act or any code, rule or regulation promulgated pursuant thereto, it shall be authorized to order such violation to cease and to take such steps necessary to enforce such an order. The said order shall state the items which are in violation and shall provide a reasonable specified time within which the violation must cease.

In any case where no code, rule or regulation has been promulgated which sets specific limits for emissions to the atmosphere of the type discovered and alleged, no order to cease such emissions shall be issued until the holding of a preliminary hearing thereon which shall be held upon not less than 15 days' notice by the department to all interested persons.

The person responsible shall make the corrections necessary to comply with the requirements of this act or code, rule or regulation promulgated pursuant thereto within the time specified in the order.

Nothing therein shall be deemed to prevent the department from prosecuting any violation of this act or any code, rule or regulation promulgated pursuant thereto notwithstanding that such violation is corrected in accordance with this order.

## 26: 2C-14.1

Any person aggrieved by an order of the department under this act may, upon application made within 15 days after notice thereof, be entitled to a hearing before the department which shall within 30 days thereafter hold a hearing of which at least 15 days written notice shall be given to such persons. Within 30 days after such hearing the department shall issue an appropriate order modifying, approving or disapproving its order. A copy of such order shall be served upon all interested parties. Pending the determination by the department and upon application therefor the department may stay the operation of such order upon such terms and conditions as it may deem proper.

(Section 15 repealed by P. L. 1962, c.215, Section 7)

## 26: 2C-16

The testimony taken at any hearing shall be under oath and recorded stenographically, but the parties shall not be bound by the strict rules of evidence prevailing in the courts of law and equity. True copies of any transcript and of any other record made of or at such hearing shall be furnished to any party thereto upon request and at his expense.

## 26: 2C-17

Any hearing required by this act to be held before the department shall be held before the State Commissioner of Health, or a member of the department designated by him, who shall have power to subpoena witnesses and compel their attendance, administer oaths and require the production for examination of any books or papers relating to any matter under investigation in any such hearing. The department, at the request of any respondent to a complaint made by it, or to it, pursuant to this act, shall subpoena and compel the attendance of such witnesses as the respondent may designate and require the production for examination of any books or papers relating to any matter under investigation in any such hearing.

(Section 18 repealed by P. L. 1962, c.215, Section 10.)

## 26: 2C-19

If any person violates any of the provisions of this act or any code, rule or regulation or order promulgated or issued pursuant to the provisions of this act, the department may institute a civil action in the Superior Court for injunctive relief to prohibit and prevent such violation or violations and the said court may proceed in the action in a summary manner.

Any person who violates the provisions of this act or any code, rule, regulation or order promulgated or issued pursuant to this act shall be liable to a penalty of not more than $2,500.00 to be collected in a civil action by a summary proceeding under the penalty enforcement law (N.J.S. 2A:58-1 et seq.) or in any case before a court of competent jurisdiction wherein injunctive relief has been requested. If the violation is of a continuing nature, each day during which it continues after the date given by which the violation must be eliminated in accordance with the order of the department shall constitute an additional, separate and distinct offense.

The department is hereby authorized and empowered to compromise and settle any claim for a penalty under this section in such amount in the discretion of the department as may appear appropriate and equitable under all of the circumstances, including a rebate of any such penalty paid to the extent of 90% thereof where such person satisfies the department within 1 year or such other period as the department may deem reasonable that such violation has been eliminated or removed or that such order or injunction has been met or satisfied, as the case may be, by the installation of air pollution control apparatus.

## 26: 2C-20

Review of any final decision or action by the department shall be by procedure in lieu of prerogative writs. Review of the validity of any code, rule or regulation promulgated by the department shall likewise be by procedure in lieu of prerogative writs.

## 26: 2C-21

No existing civil or criminal remedy for any wrongful action which is a violation of any code, rule or regulation of the commission shall be excluded or impaired by this act.

## 26: 2C-22

No ordinances of any governing body of a municipality or county or board of health more stringent than this act or any code, rules or regulations promulgated pursuant thereto shall be superseded by this act. Nothing in this act or in any code, rules or regulations promulgated pursuant thereto shall preclude the right of any governing body of a municipality or county or board of health, subject to the approval of the department, to adopt ordinances or regulations more stringent than this act or any code, rules or regulations promulgated pursuant thereto.

## 26: 2C-23

The powers, duties and functions vested in the State Department of Health under the provisions of this act shall not be construed to affect in any manner the powers, duties and functions vested in the State Department of Health under any other provisions of law.

(see footnote)

*N. B.*: C. 26:2C-8.1 to 8.5 is contained in the Motor Vehicle Law, C. 26: 2C-9.2 is contained in the Law on Permits; C. 26:2C-24 and C. 26:2C-25 are contained in the Air Pollution Scholarship and Intern Program; and C. 26:2C-26 to 2C-36 are contained in the Emergency Act—all printed separately.

# NEW JERSEY AIR POLLUTION CONTROL LAWS

*Published* by the New Jersey State Department of Health, Air Pollution Control Program, John Fitch Plaza, Trenton, N. J. 08625.

# EMERGENCY CONTROL ACT

P.L. 1967, c. 108 (Title 26, 2C:26-36) Supplements Air Pollution Control Act (P.L. 1954, c. 212).

**NOTE:** Other portions of the 1954 Act, as amended, and other air pollution laws are available. They include:

- General Provisions of 1954 Act as amended
- Motor Vehicle Law
- Permit for Construction, Installation and Alteration of Equipment
- Air Pollution Scholarship and Intern Program
- Tax Exemption for Air and Water Pollution Control Equipment
- Mid-Atlantic States Air Pollution Control Compact

**An Act providing for emergency air** pollution controls, and supplementing the "Air Pollution Control Act (1954)."

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

## 26: 2C-26

This act shall be known and may be cited as the "Air Pollution Emergency Control Act (1967)."

## 26: 2C-27

The Legislature finds and declares that air pollution may at certain times and in certain places so seriously affect the health of the public and so directly threaten the lives of large portions of the population as to warrant the provision of emergency powers as in this act provided to prevent or minimize disasters of unforseeable proportions.

## 26: 2C-28

As used in this act "area" means and refers not only to that portion or portions of the State as shall be described in the air pollution emergency declaration of the Governor but also to any other portion or portions of the State where activities are carried on which contribute or may contribute to the air pollution emergency in the portion or portions of the State described in the Governor's declaration.

## 26: 2C-29

If the State Commissioner of Health determines at any time that air pollution, in any county, locality, place or other area in the State constitutes an unreasonable and emergency risk to the health of those present within said area of the State, such determination shall be communicated in writing, with the factual findings on which such determination is based, to the Governor: the commissioner may delegate in writing to any employee of the department the power to make such determination and deliver the same to the Governor in the absence of the commissioner from the State. Upon being so advised the Governor may by proclamation declare, as to all or any part of said area mentioned in the aforesaid determination, that an air pollution emergency exists, and upon making such declaration the Governor shall have the following powers which he may exercise in whole or in part by the issuance of an order or orders:

(a) To prohibit, restrict or condition motor vehicle travel of every kind, including trucks and buses, in the area;

(b) To prohibit, restrict or condition the operation of retail, commercial, manufacturing, industrial, or similar activity in the area;

(c) To prohibit, restrict or condition operation of incinerators in the area;

(d) To prohibit, restrict or condition the burning or other consumption of any type of fuel in the area;

(e) To prohibit, restrict or condition the burning of any materials whatsoever in the [illegible];

(f) To prohibit, restrict or condition any and all other activity in the area which contributes or may contribute to the air pollution emergency.

## 26: 2C-30

The declaration by proclamation of the Governor of an air pollution emergency and any order issued by the Governor pursuant to such declaration shall be given maximum publicity throughout the State.

## 26: 2C-31

Any gubernatorial order may be amended or modified by further gubernatorial orders. Said order or orders shall not require any judicial or other order or confirmation of any type in order to become immediately effective as the legal obligation of all persons, firms, corporations and other entities within the State. Said order shall remain in effect for the duration of time set forth in same, and if no time limit is specified in said order, same shall remain in effect until the Governor declares by further proclamation that the emergency has terminated.

## 26: 2C-32

The aforesaid orders of the Governor shall be enforced by the Departments of Health, Defense, and the State and local police and air pollution enforcement personnel forces. Those enforcing any Governor's order shall require no further authority or warrant in executing same than the issuance of the order itself. Those authorized to enforce said orders may use such reasonable force as is required in the enforcement thereof, and may take such reasonable steps as are required to assure compliance therewith including, but without limiting the generality of the foregoing, the following:

(a) Entering any property or establishment whatsoever, commercial, industrial, or residential, believed to be violating said order (excepting single or double family homes or any dwelling unit within a multiple dwelling unit larger than a double family home) and, if a request does not produce compliance, causing compliance with said order;

(b) Stopping, detouring, rerouting, and prohibiting motor vehicle travel and traffic;

(c) Disconnecting incinerator or other types of combustion facilities;

(d) Terminating all burning activities;

(e) Closing down or restricting the use of any business, commercial, retail, manufacturing, industrial or other establishment.

Where any person authorized to enforce such an order believes or suspects that same is being violated in a single or double family residence or within the dwelling portion of a larger multiple dwelling unit, said residence or dwelling portion thereof may be entered only upon obtaining a search warrant from any judge having power to issue same.

## 26: 2C-33

Any person, firm, corporation or other entity within this State which violates any Governor's order with knowledge of same, or knowingly fails to comply with the directions of those authorized by the Governor to enforce said order, or knowingly interferes with the enforcement of such an order or such directions, shall be guilty of a high misdemeanor and shall be punished by a fine of not more than $100,000.00 or by imprisonment for not more than 10 years, or both.

## 26: 2C-34

No cause of action against the State or any person authorized by the Governor to enforce any order issued pursuant to this act for false arrests, false imprisonment, or other tort shall arise out of the good faith attempt of such person to enforce such order.

## 26: 2C-35

Any aggrieved person, firm or corporation or other entity upon application to the commissioner shall be granted a public hearing on the question of whether or not the continuance of any such order in whole or in part is unreasonable in the light of the then prevailing conditions of air pollution, the contribution to the same of any particular activity, and the purposes of this act Said public hearing shall be conducted as quickly as possible by said commissioner who shall give public notice of same. The commissioner shall have the power to compel attendance, testimony, and the production of documents by the use of subpoena powers. The number of witnesses and the extent of testimony shall be within his control. If the commissioner, upon conclusion of such hearing, determines that any such order should be terminated, or modified in any way whatsoever, he shall report such findings and recommendations to the Governor for such action as he deems appropriate.

## 26: 2C-36

The commissioner shall promulgate a set of proposed stand-by orders which might be appropriate for use by the Governor upon declaration of the emergency contemplated by this act. Such stand-by control proposals, when approved by the Governor, shall be distributed to the appropriate agencies and to all commercial and industrial concerns throughout this State concerned with enforcement or impact of this act and notice of their contents shall be given to the public. The commissioner shall promulgate arrangements for the enforcement of said stand-by orders and, upon approval by the Governor, notice of said arrangements shall also be distributed to said authorities, commercial and industrial concerns, and to the general public. Said proposed stand-by orders and arrangements shall not, however, become operative except when directed by the Governor in any order issued by him pursuant to a declaration of emergency under this act.

# NEW JERSEY AIR POLLUTION CONTROL LAWS

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# LAW ON PERMITS

A portion of c. 106, P. L. 1967 (Title 26, 2C:9.2) Supplements Air Pollution Control Act (P. L. 1954, c. 212).

**NOTE:** Other portions of the 1954 Act, as amended, and other air pollution laws are available. They include:

- General Provisions of 1954 Act as amended
- Motor Vehicle Law
- Emergency Control Act
- Air Pollution Scholarship and Intern Program
- Tax Exemption for Air and Water Pollution Control Equipment
- Mid-Atlantic States Air Pollution Control Compact

**Provisions concerning application** for and granting of permits to construct, install or alter equipment or control apparatus, and concerning operating certificates and emissions testing.

## C. 26: 2C-9.2

(a) No person shall construct, install or alter any equipment or control apparatus, in other than a one or 2-family dwelling or a dwelling of 6 or less family units one of which is owner-occupied, until an application including plans and specifications, has been filed with the department and an installation or alteration permit issued by the department, in accordance with any codes, rules and regulations of the department except that subject to any such codes, rules and regulations the department may dispense with the filing of applications, plans and specifications. Information relating to secret processes or methods of manufacture or production is exempted from the plans and specifications and other pertinent information to which the department is entitled under this section.

(b) No person shall use or cause to be used for any such new or altered equipment or control apparatus for which an installation or alteration permit is required or issued until an operating certificate has been issued by the department.

(c) No operating certificate or renewal thereof, required by this act, shall be issued by the department unless the applicant shows to the satisfaction of the department that the equipment is designed to operate without causing a violation of any provision of this act or of any codes, rules and regulations promulgated thereunder and that, excep. the case of a renewal certificate, the equipment incorporates advances in the art of air pollution control developed for the kind and amount of air contaminant emitted by the applicant's equipment.

(1) Before an operating certificate or any renewal thereof is issued, the department may require the applicant to conduct such tests as are necessary in the opinion of the department to determine the kind or amount of the air contaminant emitted from the equipment or whether the equipment or fuel or the operation of the equipment is in violation of any of the provisions of this act or of any codes, rules and regulations promulgated thereunder. Such tests shall be made at the expense of the applicant and shall be conducted in a manner approved by the department and the test results shall be reviewed and professionally certified.

(2) An operating certificate or any renewal thereof shall be valid for a period of 5 years from the date of issuance, unless sooner revoked by order of the department, and may be renewed upon application to the department.

(3) Upon receipt of an application for the issuance of an operating certificate or any renewal thereof, the department, in its discretion, may issue a temporary operating certificate valid for a period not to exceed 90 days.

# NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
# NEW JERSEY AIR POLLUTION CONTROL CODE

# CHAPTER 4
# CONTROL AND PROHIBITION OF AIR POLLUTION BY SMOKE

**Original Effective Date January 1, 1958**
**Revised Version Signed November 10, 1971**
**Filed with the Secretary of State November 17, 1971**
**To be effective January 16, 1972**

CHAPTER 4 CONTROL AND PROHIBITION OF AIR POLLUTION BY SMOKE, which became effective January 1, 1958 is hereby repealed. This repeal shall not affect actions, proceedings, or departmental orders pending or outstanding on the effective date of the new regulation; said actions, proceedings, or departmental orders may be prosecuted, defended and continued in the same manner and to the same effect as if the new regulation had not been adopted. The text of the new regulation follows.

## CHAPTER 4

### CONTROL AND PROHIBITION OF SMOKE FROM COMBUSTION OF FUEL

#### Section 1 - Definitions

1.1 SMOKE: Small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

1.2 FUEL: Solid, liquid or gaseous materials used to produce useful heat by burning.

1.3 INDIRECT HEAT EXCHANGER: Equipment in which heat from the combustion of fuel is transferred by conduction through a heat-conducting material to a substance being heated, so that the latter is not contacted by, and adds nothing to, the products of combustion.

1.4 VISIBLE SMOKE: Smoke which obscures light to a degree readily discernible by visual observation.

1.5 STACK OR CHIMNEY: A flue, conduit or opening designed and constructed for the purpose of emitting air contaminants into the outdoor air.

1.6 INTERNAL CROSS-SECTIONAL DIMENSION: Any maximum linear perpendicular distance from an inside wall of a stack or chimney to the inside of an opposite wall, such as the diameter of a circular cross-section or the length or width of a rectangular cross-section.

1.7 RINGELMANN SMOKE CHART: The Ringelmann's Scale for Grading the Density of Smoke as published by the U.S. Bureau of Mines or any chart, recorder, indicator or device which is approved by the department as the equivalent of said Ringelmann's Scale for the measurement of smoke density.

1.8 DEPARTMENT: The Department of Environmental Protection.

1.9 OPACITY: The property of a substance which renders it partially or wholly obstructive to the transmission of visible light expressed as the percentage to which the light is obstructed.

1.10 MARINE INSTALLATION: Equipment for propulsion, power or heating on all types of marine craft and floating equipment.

1.11 MOBILE SOURCE: Equipment designed or constructed to be portable or movable from one location to another including but not limited to aircraft, locomotives operating on rails, tractors, earth moving equipment, hoists and mobile power generators.

1.12 DIRECT HEAT EXCHANGER: Equipment in which heat from the combustion of fuel is transferred to a substance being heated so that the latter is contacted by the products of combustion and may contribute to the total effluent.

1.13 MANUFACTURING PROCESS: Any action, operation or treatment embracing chemical, industrial, manufacturing, or processing factors, methods or forms including, but not limited to, furnaces, kettles, ovens, converters, cupolas, kilns, crucibles, stills, dryers, roasters, crushers, grinders, mixers, reactors, regenerators, separators, filters, reboilers, columns, classifiers, screens, quenchers, cookers, digesters, towers, washers, scrubbers, mills, condensers or absorbers.

1.14 MOTOR VEHICLE: Any vehicle propelled

otherwise than by muscular power, excepting such vehicles as run only upon rails or tracks.

## Section 2 Smoke Emissions from Stationary Indirect Heat Exchangers

2.1 No person shall cause, suffer, allow or permit visible smoke to be emitted into the outdoor air from the combustion of fuel in any stationary indirect heat exchanger having a rated hourly capacity of less than 200 million BTU gross heat input or discharging through a stack or chimney having an internal cross-sectional dimension of less than 60 inches.

2.2 No person shall cause, suffer, allow or permit smoke the shade or appearance of which is darker than Number 1 on the Ringelmann Smoke Chart or greater than 20 percent opacity, exclusive of water vapor, to be emitted into the outdoor air from the combustion of fuel in any stationary indirect heat exchanger having a rated hourly capacity of 200 million BTU or greater gross heat input or discharging through a stack or chimney having all internal cross-sectional dimensions of 60 inches or greater.

2.3 The provisions of Section 2.1 and 2.2 shall not apply to smoke which is visible for a period of not longer than three minutes in any consecutive 30 minute period.

## Section 3 Smoke Emissions from Marine Installations

3.1 No person shall cause suffer, allow or permit smoke the shade or appearance of which is darker than Number 1 on the Ringelmann Smoke Chart or greater than 20 percent opacity, exclusive of water vapor, to be emitted into the outdoor air from the combustion of fuel in the indirect heat exchanger of any marine installation.

3.2 The provisions of Section 3.1 shall not apply to smoke which is visible for a period of not longer than three minutes in any consecutive 30 minute period.

NEW JERSEY STATE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
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## Section 4 Smoke Emissions from the Combustion of Fuel in Mobile Sources

4.1 No person shall cause, suffer, allow or permit smoke the shade or appearance of which is darker than Number 2 on the Ringelmann Smoke Chart or greater than 40 percent opacity, exclusive of water vapor, to be emitted into the outdoor air from the combustion of fuel in any mobile source for a period of more than 10 consecutive seconds.

## Section 5 Smoke Emissions from Stationary Internal Combustion Engines and Stationary Turbine Engines

5.1 No person shall cause, suffer, allow or permit smoke the shade or appearance of which is darker than Number 1 on the Ringelmann Smoke Chart or greater than 20% opacity, exclusive of water vapor, to be emitted into the outdoor air from the combustion of fuel in any stationary internal combustion engine or any stationary turbine engine for a period of more than 10 consecutive seconds.

## Section 6 Stack Test

6.1 Any person responsible for the construction, installation, alteration or use of an indirect heat exchanger shall, when requested by the department, provide the facilities and necessary equipment for determining the density or opacity of smoke being discharged into the open air and shall conduct such smoke tests using methods approved by the department. All smoke test data shall be recorded in a permanent log at such time intervals as specified by the department. The data shall be maintained for a period of not less than one year and shall be available for review by the department.

## Section 7 Exceptions

7.1 The provisions of this chapter shall not apply to direct heat exchangers, manufacturing processes or any motor vehicle while operating upon the public highways.

# NEW JERSEY STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION
# NEW JERSEY AIR POLLUTION CONTROL CODE

# CHAPTER 5
# CONTROL AND PROHIBITION OF SOLID PARTICLES FROM COMBUSTION OF FUEL

**Original Effective Date: July 1, 1958**
**Amended: March 1, 1966**

**Revised Version Promulgated: January 27, 1972**
**To be Effective: March 27, 1972**

Chapter 5 – CONTROL AND PROHIBITION OF AIR POLLUTION FROM COMBUSTION OF SOLID FUEL, which became effective on July 1, 1958, and was amended March 1, 1966, is hereby repealed. This repeal shall not affect actions, proceedings, or departmental orders pending or outstanding on the effective date of the new regulation; said actions, proceedings, or departmental orders may be prosecuted, defended and continued in the same manner and to the same effect as if the new regulation had not been adopted. The text of the new regulation follows.

## Section 1 – Definitions

1.1 SOLID PARTICLES: Particles of rigid shape and definite volume.

1.2 PARTICLES: Any material, except uncombined water, which exists in a finely divided form as liquid particles or solid particles at standard conditions.

1.3 LIQUID PARTICLES: Particles which have volume but are not of rigid shape and which upon collection tend to coalesce and create uniform homogeneous films upon the surface of the collecting media.

1.4 STANDARD CONDITIONS: Shall be 70° F and one atmosphere pressure (14.7 psia or 760 mm Hg).

1.5 DEPARTMENT: The Department of Environmental Protection.

1.6 FUEL: Solid, liquid or gaseous materials used to produce useful heat by burning.

1.7 STACK OR CHIMNEY: A flue, conduit or opening designed and constructed for the purpose of emitting air contaminants into the outdoor air.

1.8 AIR CONTAMINANT: Solid particles, liquid particles, vapors or gases which are discharged into the outdoor atmosphere.

1.9 MAXIMUM ALLOWABLE EMISSION RATE: The maximum amount of an air contaminant which may be emitted into the outdoor air at any instant in time or during any prescribed interval of time.

1.10 HEAT INPUT RATE: The rate at which the aggregate heat content based on the higher heating value of the fuel is introduced into the fuel burning equipment.

1.11 PERFORMANCE TEST PRINCIPLE: A concept of measurement as required for determining compliance with a specific standard for the emission of air contaminants.

1.12 ISOKINETIC: A method for sampling air contaminants from the gas stream in a stack or chimney in such a manner that the gas stream enters a sampling probe in the same direction and at the same velocity as the gas stream in a stack or chimney.

1.13 SAMPLING TRAIN: A combination of entrapment devices, instruments, and auxiliary apparatus arranged in a prescribed sequence to selectively separate and collect samples of specified air contaminants.

1.14 EQUIPMENT: Any device capable of causing the emission of an air contaminant into the open air and any stack, chimney, conduit, flue, duct, vent or similar device connected or attached to, or serving the equipment. This shall include equipment in which the preponderance of the air contaminants emitted is caused by the manufacturing process.

1.15 MANUFACTURING PROCESS: Any action, operation or treatment embracing chemical, industrial, manufacturing, or processing factors, methods or forms including, but not limited to, furnaces, kettles, ovens, converters, cupolas, kilns, crucibles, stills, dryers, roasters, crushers, grinders, mixers, reactors, regenerators, separators, filters, reboilers, columns, classifiers, screens, quenchers, cookers, digesters, towers, washers, scrubbers, mills, condensers or absorbers.

1.16 CONTROL APPARATUS: Any device which prevents or controls the emission of any air contaminant.

1.17 MARINE INSTALLATION: Equipment for propulsion, power or heating on all types of marine craft and floating equipment.

## Section 2 – Standards for the Emission of Particles

2.1 No person shall cause, suffer, allow or permit solid particles arising from the combustion of fuel to be emitted from any stack or chimney into the outdoor air in excess of the maximum allowable emission rate as determined from Table 1. For a heat input rate between any two consecutive heat input rates stated in Table 1, the maximum allowable emission rate shall be as determined by interpolation.

**TABLE 1**

| HEAT INPUT RATE (Millions of British Thermal Units per Hour) | MAXIMUM ALLOWABLE EMISSION RATE (Pounds per Hour) |
|---|---|
| 1 | 0.6 |
| 10 | 6 |
| 20 | 8 |
| 30 | 9 |
| 40 | 10 |
| 50 | 11 |
| 60 | 12 |
| 70 | 13 |
| 80 | 14 |
| 90 | 14.5 |
| 100 | 15 |
| 120 | 16.5 |
| 140 | 17.5 |
| 160 | 18.5 |
| 180 | 19.3 |
| 200 | 20 |
| 400 | 40 |
| 600 | 60 |
| 800 | 80 |
| 1,000 | 100 |
| 2,000 | 200 |
| 3,000 | 300 |
| 4,000 | 400 |
| 5,000 | 500 |
| 6,000 | 600 |
| 7,000 | 700 |
| 8,000 | 800 |
| 10,000 | 1,000 |

**NOTE:** Heat input rate shall be the sum of the heat input rates of all fuel burning equipment discharging through a single stack or chimney.

## Section 3 – Performance Test Principle

3.1 For purposes of measuring emissions in accordance with the provisions of this chapter, solid particles shall be drawn by isokinetic procedures from the stack or chimney and the weight of the solid particles determined gravimetrically after removal of uncombined water. The measured emission weight shall be the combined weight of all solid particles collected from the gas stream. The specifications for the sampling train and sample procedures shall be as published by the Department or approved equivalent.

## Section 4 – Emission Tests

4.1 Any person responsible for the emission of solid particles arising from the combustion of fuel shall, when requested by the Department, provide such sampling facilities exclusive of instrumentation and sensing devices as may be necessary for the Department to determine the rate at which the particles are or may be discharged from the fuel burning operation. During such testing by the Department, the fuel burning operation shall be operated under normal, routine operating conditions or under such other conditions within the capacity of the equipment as may be requested by the Department. The facilities may be either permanent or temporary, at the discretion of the person responsible for their provision, and shall conform to all applicable laws and regulations concerning safe construction and safe practice.

## Section 5 – Permit to Construct, Install or Alter and Certificate to Operate

5.1 No person shall construct or install any new fuel burning equipment, or any new control apparatus, or alter any existing fuel burning equipment, or any control apparatus without first having obtained a "Permit to Construct, Install or Alter Control Apparatus or Equipment" from the Department, in accordance with the provisions of Chapter 9 of the New Jersey Air Pollution Control Code.

5.2 No person shall use or cause to be used any new or altered fuel burning equipment, or any new or altered control apparatus without first having obtained a "Certificate to Operate Control Apparatus or Equipment" from the Department, in accordance with Chapter 9 of the New Jersey Air Pollution Control Code.

5.3 No person shall use or cause to be used any fuel burning equipment unless all components connected, or attached to, or serving the equipment, including control apparatus, are functioning properly and are in use, in accordance with the Permit to Construct and the Certificate to Operate.

## Section 6 – Exceptions

6.1 The provisions of this Chapter shall not apply:

(a) when the heat input rate to the fuel burning equipment is less than 1,000,000 British Thermal Units per hour,

(b) to marine installations, vehicles or other movable or portable equipment.

Air D-29
Oct. '68

# NEW JERSEY AIR POLLUTION CONTROL CODE

New Jersey State
Department of Health
John Fitch Plaza, P.O. Box 1540
Trenton, New Jersey 08625

# CHAPTER 9 - PERMITS

## Permits to Construct, Install or Alter and Certificates to Operate Control Apparatus or Equipment

The Air Pollution Control Code consists of a group of administrative regulations published as chapters. These regulations have the force and effect of law. By law, the authority to promulgate such regulations, after public hearing, is vested in the New Jersey State Department of Health.

**NOTE:** Other chapters of the New Jersey Air Pollution Control Code available are:

1 Definitions
2 Open Burning
3 Municipal Regulations
4 Smoke
5 Solid Fuel
6 Prohibition of Air Pollution
7 Solid Particles
8 Sulfur Compounds from Industrial Processes
9 Permits
10 Sulfur in Fuels (Oil)
10A Sulfur in Coal
11 Incinerators

**NOTE**

Application forms may be secured by writing to Supervisor of Permits & Certificates, Air Pollution Control Program, New Jersey State Department of Health, P.O. Box 1540, Trenton, New Jersey 08625.

**Filed in Secretary of State's Office**
**on November 15, 1967**
**Effective Date: January 15, 1968**

### SECTION 1 — DEFINITIONS

1.1 CONTROL APPARATUS: Any device which prevents or controls the emission of any air contaminant.

1.2 EQUIPMENT: Any device capable of causing the emission of an air contaminant into the open air, and any stack, chimney, conduit, flue, duct, vent or similar device connected or attached to, or serving the equipment. This shall include equipment in which the preponderance of the air contaminants emitted is caused by the manufacturing process.

1.3 MANUFACTURING PROCESS: Any action, operation or treatment embracing chemical, industrial, manufacturing, or processing factors, methods or forms including but not limited to furnaces, kettles, ovens, converters, cupolas, kilns, crucibles, stills, dryers, roasters, crushers, grinders, mixers, reactors, regenerators, separators, filters, reboilers, columns, classifiers, screens, quenchers, cookers, digestors, towers, washers, scrubbers, mills, condensors or absorbers.

1.4 SOURCE OPERATION: Any manufacturing process or any identifiable part thereof emitting an air contaminant into the outdoor atmosphere through one or more stacks or chimneys. For purposes of this definition identical processes shall be considered as separate source operations.

1.5 AIR CONTAMINANT: Any coarse and fine solid particles, liquid particles, vapors or gases which are discharged into the outdoor atmosphere.

1.6 STACK OR CHIMNEY: A flue, conduit or opening permitting an air contaminant to be emitted into the open air, or constructed or arranged for such purpose.

1.7 COMMERCIAL FUEL: Solid, liquid or gaseous fuels normally produced, manufactured, used or sold for the purpose of creating useful heat.

1.8 NON-COMMERCIAL FUEL: Solid, liquid or gaseous fuel not normally produced, manufactured, used or sold for the purpose of creating useful heat.

1.9 SOLID FUEL: A fuel which is fired as a solid, such as anthracite or semianthracite coal, bituminous or sub-bituminous coal, lignite, coke breeze, wood or any solid by-product of a manufacturing process that may be substituted for any of the above specifically mentioned fuels.

1.10 INCINERATOR: Any device, apparatus, equipment or structure used for destroying, reducing or salvaging by fire any material or substance including but not limited to refuse, rubbish, garbage, trade waste, debris or scrap or facilities for cremating human or animal remains.

### SECTION 2 — CONTROL APPARATUS AND EQUIPMENT FOR WHICH A PERMIT TO CONSTRUCT AND A CERTIFICATE TO OPERATE ARE REQUIRED.

2.1 All control apparatus.

2.2 Equipment used in a manufacturing process involving surface coating, including but not limited to spray and dip painting, roller coating, electrostatic depositing or spray cleaning which emits air contaminants into the open air and in which the quantity of material used in any source operation is in excess of (10) ten pounds in any one hour.

2.3 Equipment used in a manufacturing process involving metal cleaning or surface preparation, including but not limited to degreasing, etching, pickling, or plating which emits air contaminants into the open air from a tank or vessel, the capacity of which is in excess of (100) one hundred gallons.

*Continued on Reverse Side*

2.4 Equipment, used in a manufacturing process, other than as set forth in Sections 2.2 and 2.3, which emits air contaminants into the open air either directly or indirectly and in which the combined weight of all materials, excluding air and water, introduced into any one source operation is in excess of (50) fifty pounds in any one hour.

2.5 Liquid storage tanks, reservoirs, and containers, used for the storage of acids, solvents, diluents or thinners, inks, colorants, lacquers, enamels, varnishes, liquid resins and having a capacity in excess of 10,000 gallons.

2.6 Pneumatic material handling or conveying systems.

2.7 Commercial fuel burning equipment in which the rate of solid fuel burned is in excess of one million BTU's in any one hour.

2.8 Any equipment used for the burning or incineration of noncommercial fuel or process by-products in the form of liquid, solid or gas.

2.9 Any incinerator, except incinerators constructed, installed or used in one- or two-family dwellings or in multi-occupied dwellings containing (6) six or less family units, one of which is owner occupied.

## SECTION 3 – PERMITS AND CERTIFICATES REQUIRED

3.1 PERMIT TO CONSTRUCT: No person shall construct, install or alter any equipment or control apparatus without first having obtained a "Permit to Construct, Install or Alter Control Apparatus or Equipment" from the State Department of Health.

3.2 CERTIFICATE TO OPERATE: No person shall use or cause to be used any new or altered equipment or control apparatus without first having obtained a "Certificate to Operate Control Apparatus or Equipment" from the Department. Such certificates shall be valid for a period of five years unless sooner revoked by the Department, and such certificate may be renewed only after application to the Department not less than 90 days prior to their expiration date.

3.2.1 TRANSFERS: A "Certificate to Operate" shall not be transferable, either from one location to another, or from one piece of equipment to another.

3.2.2 CONDITIONAL APPROVAL: Upon receipt of an application for the issuance of a "Certificate to Operate" or any renewal thereof, the Department may issue a temporary certificate valid for a period not to exceed 90 days.

3.2.3 The possession of a "Certificate to Operate" does not relieve any person from the obligation to comply with all other provisions of the Air Pollution Control Code.

3.2.4 Permits to construct and certificates to operate issued under this chapter are based on control of air contaminants only and do not in any way void the applicant's obligation to obtain necessary permits from other governmental agencies.

3.2.5 Any person in possession of a "Certificate to Operate" shall maintain said certificate readily available on the operating premises.

3.3 EXEMPTIONS: The provisions of Sections 3.1 and 3.2 shall not apply to structural changes, repairs or maintenance, or identical replacement in whole or in part of any article, machine, equipment or contrivance if such changes, or repairs or maintenance, or replacement cannot change the quality, nature or quantity of air contaminants.

## SECTION 4 – APPLICATIONS FOR PERMITS TO CONSTRUCT AND CERTIFICATES TO OPERATE

4.1 Applications for a permit to construct or a certificate to operate shall be made to the Department on forms provided by the Department.

The Department may require such details regarding the equipment or control apparatus as it considers necessary to determine that the equipment or control apparatus is designed to operate without causing a violation of any provisions of the New Jersey Air Pollution Control Act or any provisions of codes, rules or regulations promulgated thereunder and that the equipment or control apparatus incorporates advances in the art of air pollution control developed for the kind and amount of air contaminant emitted by the applicant's equipment. Such information may include description of processes, raw materials used, operating procedures, physical and chemical nature of air contaminants, volume of gas discharged and such other information as the Department considers necessary.

4.2 Before a "Certificate to Operate" or any renewal thereof is issued, the Department may require the applicant to conduct such tests as are necessary in the opinion of the Department to determine the kind and/or amount of air contaminants emitted from the equipment or control apparatus. Such tests shall be made at the expense of the applicant and shall be conducted in a manner approved by the Department, and the test results shall be reviewed and certified by a New Jersey licensed Professional Engineer, or by an Industrial Hygienist, who has been certified by the American Academy of Industrial Hygiene.

Effective May 2, 1970 wherever Department and/or Commissioner of Health appears it shall mean and refer to the Department and/or Commissioner of Environmental Protection. Division of Clean Air and Water shall mean and refer to the Division of Environmental Quality of the Department of Environmental Protection.

Air-D41
Apr 70

# NEW JERSEY AIR POLLUTION CONTROL CODE

New Jersey State
Department of Health
John Fitch Plaza, P.O. Box 1540
Trenton, New Jersey 08625

# CHAPTER 10 -- SULFUR IN FUELS

## Control and Prohibition of Air Pollution from Sulfur Dioxide Caused by the Combustion of Fuel

The Air Pollution Control Code consists of a group of administrative regulations published as chapters. These regulations have the force and effect of law. By law, the authority to promulgate such regulations after public hearing is vested in the New Jersey State Department of Health.

**NOTE: The chapters of the New Jersey Air Pollution Control Code are:**



## New Jersey State Department of Health
## Division of Clean Air and Water
## New Jersey Air Pollution Control Code

## CHAPTER X

### Control and Prohibition of Air Pollution from Sulfur Dioxide Caused by the Combustion of Fuel

Filed in Secretary of State's Office
on January 12, 1968
Effective Date: May 1, 1968

### SECTION 1 -- DEFINITIONS

The following terms as used in this Chapter shall mean and include:

1.1 COMMERCIAL FUEL: Liquid or gaseous fuel normally produced, manufactured, used or sold for the purpose of creating useful heat.

1.2 NON-COMMERCIAL FUEL: Liquid or gaseous fuel not normally produced, manufactured, used or sold for the purpose of creating useful heat.

1.3 FUEL OIL: A liquid or liquefiable petroleum product burned for lighting or for the generation of heat or power and derived directly or indirectly from crude oil.

1.4 VISCOSITY: The measure of a fluid's resistance to flow.

1.5 SSU VISCOSITY: The number of seconds it takes 60 cubic centimeters of an oil to flow through the standard orifice of a Saybolt Universal viscometer at 100 F.

1.6 SULFUR DIOXIDE ($SO_2$): A colorless gas at standard conditions which has the molecular formula $SO_2$.

1.7 STACK OR CHIMNEY: A flue, conduit or opening permitting particulate or gaseous emissions into the open air, or constructed or arranged for such purpose.

1.8 CARBON DIOXIDE ($CO_2$): A colorless, odorless gas at standard conditions which has the molecular formula $CO_2$.

1.9 FUEL MERCHANT: Any person who stores, offers for sale or sells commercial fuel in retail or wholesale trade, excluding agents, brokers, wholesalers, distributors or producers who sell commercial fuel for use in single steam and/or electric power generating facilities having rated hourly capacities that equal or exceed two hundred (200) million BTU gross heat input, or in a group of steam and/or electric power generating facilities at one location having a combined rated capacity which equals or exceeds four hundred and fifty (450) million BTU gross heat input.

### SECTION 2 -- COMMERCIAL FUEL OIL

2.1 On and after the effective dates listed therein no fuel merchant shall store, offer for sale, sell, deliver for use or exchange in trade, for use in New Jersey, and no person shall use commercial fuel oils which contain sulfur in excess of the percentages by weight set forth in the following table:

| Grades of Commercial Fuel Oil | Classification by SSU Viscosity at 100°F | Percent Sulfur by Weight Effective 5/1/68 | Effective 10/1/70 | Effective 10/1/71 |
|---|---|---|---|---|
| No. 2 & lighter | Less than or equal to 45 | 0.3% | 0.3% | 0.2% |
| No. 4 | Greater than 45 but less than 145 | 0.7% | 0.4% | 0.3% |
| No. 5, No. 6 & heavier | Equal to or greater than 145 | 1.0% | 0.5% | 0.3% |

2.2 The provisions of Section 2.1 shall not apply in any case in which it is demonstrated to the Department that sulfur dioxide emissions, caused by the combustion of commercial fuel oils, from any stack or chimney into the outdoor atmosphere, can be controlled to levels that, on and after the effective dates listed herein, do not exceed at any time those quantities of sulfur dioxide, expressed in pounds per one (1) million BTU gross heat input, set forth in the following table:

| Grades of Commercial Fuel Oil | Classification by SSU Viscosity at 100°F | Permissible $SO_2$ Emissions (Pounds $SO_2$ per Million BTU Gross Heat Input) Effective 5/1/68 | Effective 10/1/70 | Effective 10/1/71 |
|---|---|---|---|---|
| No. 4 | Greater than 45 but less than 145 | 0.74 lbs. | 0.42 lbs. | 0.30 lbs. |
| No. 5, No. 6 & heavier | Equal to or greater than 145 | 1.1 lbs. | 0.52 lbs. | 0.30 lbs. |

### SECTION 3 -- NON-COMMERCIAL FUEL

3.1 On and after May 1, 1968 no person shall cause, suffer, allow or permit sulfur dioxide, caused by the combustion of non-commercial fuel or the combustion of non-commercial and commercial fuel mixtures, to be discharged from any stack or chimney into the outdoor atmosphere at any time in excess of 640 ppm by volume adjusted to twelve (12) percent carbon dioxide

(Continued on Reverse Side)

## NEW JERSEY STATE
## DEPARTMENT OF HEALTH

Pursuant to authority vested in it under the provisions of the Air Pollution Control Act, the State Department of Health hereby promulgates the following regulations concerning air pollution from sulfur dioxide caused by the combustion of fuel, to become effective May 1, 1968.

ROSCOE P. KANDLE, M.D.

*State Commissioner of Health*

## FOREWORD

On June 15, 1967, Governor Richard J. Hughes signed into law Senate Bill No. 345. This law, chapter 196, P.L. 1967 (N.J.S.A. 26:2C-8), gives the State Department of Health "... power to formulate and promulgate, amend and repeal codes, and rules and regulations preventing, controlling and prohibiting air pollution ..."

The proposed Air Pollution Code Chapter X was advertised August 9, 1967 and public hearings were held thereon on September 11 and 18, and October 6 and 9 as required by statute. The code Chapter, with certain modifications, was adopted by the State Department of Health on January 12, 1968 and was promulgated on the same day. The text of the code as promulgated is reproduced herein.

## CHAPTER X – Continued

by volume; and, on and after October 1, 1971 no person shall cause, suffer, allow or permit sulfur dioxide, caused by the combustion of non-commercial fuel or the combustion of non-commercial and commercial fuel mixtures, to be discharged from any stack or chimney into the outdoor atmosphere at any time in excess of 310 ppm by volume adjusted to twelve (12) percent carbon dioxide by volume.

3.2 Any person responsible for the discharge of sulfur dioxide, caused by the combustion of non-commercial fuel or the combustion of non-commercial and commercial fuel mixtures, from any stack or chimney into the outdoor atmosphere shall provide the facilities and necessary equipment and shall conduct stack tests using methods approved by the Department. Such tests shall include a determination of the percent by volume of the concentrations of sulfur dioxide and carbon dioxide at the sampling point in the stack or chimney, and the data shall be recorded in a permanent log at least once each hour. These data shall be maintained for a period of not less than one year and shall be available for review by the Department.

### SECTION 4 – EXEMPTIONS

4.1 The provisions of this chapter shall not apply to commercial fuel used by ocean-going vessels or in internal combustion engines.

4.2 The requirements of this chapter which are to become effective on October 1, 1970 and October 1, 1971 shall not apply to commercial fuel used in Atlantic, Cape May, Cumberland, Hunterdon, Ocean, Sussex and Warren Counties.

4.3 The requirements of this chapter shall not preclude the use after May 1, 1968 of any commercial or non-commercial fuel on hand at the place of use on May1,1968.

M7062

NEW JERSEY STATE
DEPARTMENT OF HEALTH
P.O. BOX 1540
TRENTON, N. J. 08625

Effective May 2, 1970 wherever Department and/or Commissioner of Health appears it shall mean and refer to the Departme and/or Commissioner of Environmental Protection. Division of Clean Air and Water shall mean and refer to the Division of Environmental Quality of the Department of Environmental Protection.

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Apr 70

# NEW JERSEY AIR POLLUTION CONTROL CODE

New Jersey State
Department of Health
John Fitch Plaza, P.O. Box 1540
Trenton, New Jersey 08625

# CHAPTER 11 - INCINERATORS

## Control and Prohibition of Air Pollution From Incinerators

The Air Pollution Control Code consists of a group of administrative regulations published as chapters. These regulations have the force and effect of law. By law, the authority to promulgate such regulations after public hearing is vested in the New Jersey State Department of Health.

NOTE: The chapters of the New Jersey Air Pollution Control Code are:



**Filed in Secretary of State's Office on June 12, 1968**

**Effective Date: August 15, 1968**

### SECTION 1 — DEFINITIONS

The following terms as used in this chapter shall mean and include:

1.1 INCINERATOR: Any device, apparatus, equipment or structure used for destroying, reducing or salvaging by fire any material or substance including but not limited to refuse, rubbish, garbage, trade waste, debris or scrap or a facility for cremating human or animal remains.

1.2 COMMON INCINERATOR: An incinerator designed and used to burn waste materials of Types 0, 1, 2, and 3 only, in all capacities not exceeding 2,000 pounds per hour of waste material input.

1.3 SPECIAL INCINERATOR: Municipal, pathological waste, or trade waste incinerator of any burning capacity, or any incinerator with a burning capacity in excess of 2,000 pounds per hour.

1.4 MUNICIPAL INCINERATOR: An incinerator owned or operated by government or by a person who provides incinerator service to government or others, and designed and used to burn waste materials of any and all types, 0 to 6 inclusive.

1.5 PATHOLOGICAL WASTE INCINERATOR: An incinerator designed and used to burn Type 4 waste materials, primarily human and animal remains, in all burning capacities. Crematoriums are included in this category.

1.6 TRADE WASTE INCINERATOR: An incinerator designed and used to burn waste material primarily of Types 5 and 6, either separately or together with waste materials of Types 0, 1, and 3.

1.7 TYPE 0 WASTE: Trash, a mixture of highly combustible waste such as paper, cardboard, cartons, wood boxes and combustible floor sweepings, containing approximately 10% moisture and 5% incombustible solids, and having a heating value of approximately 8500 BTU per pound as fired, and deriving from commercial and industrial activities. The mixtures contain up to 10% by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags and plastic or rubber scraps.

1.8 TYPE 1 WASTE: Rubbish, a mixture of combustible waste such as paper, cardboard cartons, wood scraps, foliage and combustible floor sweepings, containing approximately 25% moisture and 10% incombustible solids and having a heating value of approximately 6500 BTU per pound as fired, and deriving from domestic, commercial and industrial activities. The mixture contains up to 20% by weight of restaurant or cafeteria waste, but contains little or no treated paper, plastic or rubber wastes.

1.9 TYPE 2 WASTE: Refuse, consisting of an approximately even mixture of rubbish and garbage by weight, containing up to 50% moisture and approximately 7% incombustible solids, and having a heating value of approximately 4300 BTU per pound as fired, and commonly deriving from apartment and residential occupancy.

1.10 TYPE 3 WASTE: Garbage, consisting of animal and vegetable wastes containing up to 70% moisture and up to 5% incombustible solids and having a heating value of approximately 2500 BTU per pound as fired and deriving from restaurants, cafeterias, hotels, hospitals, markets, and like installations.

1.11 TYPE 4 WASTE: Human and animal remains, consisting of carcasses, organs and solid organic wastes from hospitals, laboratories, abattoirs, animal pounds, and similar sources, consisting of up to 85% moisture and approximately 5% incombustible solids and having a heating value of approximately 1,000 BTU per pound as fired.

1.12 TYPE 5 WASTE: By-product waste, gaseous, liquid or semi-liquid, such as tar, paints, solvents, sludge, fumes, et cetera, from industrial operations.

1.13 TYPE 6 WASTE: Solid by-product waste, such as rubber, plastics, wood waste, et cetera, from industrial operations.

1.14 MULTIPLE CHAMBER INCINERATOR: An incinerator with two or more refractory-lined combustion chambers in series physically separated by refractory walls, interconnected by gas passages, and employing adequate design parameters necessary for maximum combustion of the waste materials.

1.15 NEW INCINERATOR: An incinerator purchased or constructed after the effective date of this chapter.

1.16 EXISTING INCINERATOR: An incinerator purchased, acquired, or used before the effective date of this Chapter.

1.17 DEPARTMENT: The State Department of Health.

1.18 SINGLE FLUE-FED INCINERATOR: An incinerator provided with a single flue which serves as both the charging chute and the flue to transport products of combustion to the atmosphere.

1.19 PARTICLES: Any material, except uncombined water, which exists in a finely divided form as liquid particles or solid particles at standard conditions.

1.20 LIQUID PARTICLES: Particles which have volume but are not of rigid shape and which upon collection tend to coalesce and create uniform homogeneous films upon the surface of the collecting media.

1.21 SOLID PARTICLES: Particles of rigid shape and definite volume.

1.22 STANDARD CONDITIONS: Shall be 70 F and one atmosphere pressure (14.7 psia or 760 mm Hg).

1.23 AUXILIARY FUEL: Fuel other than waste materials used to attain temperatures sufficiently high, (a) to dry and ignite waste materials (b) to maintain ignition thereof, or (c) to effect complete combustion of combustible solids, vapors and gases.

1.24 SMOKE: Shall mean and include small gas-borne and air-borne particles arising from a process of combustion in sufficient number to be observable.

1.25 RINGELMANN SMOKE CHART: Shall be the Ringelmann Scale for Grading the Density of Smoke published by the U. S. Bureau of Mines or any chart, recorder, indicator or device for the measurement of smoke density which is approved by the Department as the equivalent of said Ringelmann Scale.

1.26 CONTROL APPARATUS: Any device which prevents or controls the emission of any air contaminant.

## SECTION 2 — CONSTRUCTION STANDARDS

2.1 MULTIPLE CHAMBERS

(a) No person shall construct, install, use or cause to be used any new incinerator unless such incinerator is of the multiple chamber type or of a type approved by the Department as being equally effective for the purpose of air pollution control.

(b) Two years from the effective date of this Chapter, no person shall use or cause to be used an existing incinerator unless such incinerator is of the multiple chamber type or of a type approved by the Department as being equally effective for the purpose of air pollution control.

2.2 No person shall construct, install, use, or cause to be used any new single flue-fed incinerator.

## SECTION 3 — EMISSION STANDARDS

3.1 PARTICLES

(a) No person shall construct, install, use, or cause to be used any new common incinerator or alter or relocate and use or cause to be used any existing common incinerator which will emit more than 0.2 grains of particles including ash per cubic foot of dry flue gas at standard conditions corrected to 12 per cent carbon dioxide by volume excluding the contribution of auxiliary fuel.

(b) No person shall construct, install, use, or cause to be used any new special incinerator or alter or relocate and use or cause to be used any existing special incinerator which will emit more than 0.1 grains of particles including ash per cubic foot of dry flue gas at standard conditions corrected to 12 per cent carbon dioxide by volume excluding the contribution of auxiliary fuel.

(c) Two years from the effective date of this Chapter, no person shall use or cause to be used any existing common incinerator which will emit more than 0.2 grains of particles, including ash per cubic foot of dry flue gas at standard conditions corrected to 12 per cent carbon dioxide by volume excluding the contribution of auxiliary fuel

(d) Two years from the effective date of this Chapter, no person shall use or cause to be used any existing special incinerator which will emit more than 0.1 grains of particles, including ash per cubic foot of dry flue gas at standard conditions corrected to 12 per cent carbon dioxide by volume excluding the contribution of auxiliary fuel.

3.2 SMOKE

(a) The provisions of Chapter IV of the New Jersey Air Pollution Control Code insofar as they relate to smoke from incinerators are superseded by this section.

(b) No person shall cause, suffer, allow or permit smoke from any incinerator the shade or appearance of which is darker than No. 1 of the Ringelmann Smoke Chart to be emitted into the open air; or emissions of such opacity within a stack or chimney, or exclusive of water vapor, of such opacity leaving a stack or chimney to a degree greater than the emission designated as No. 1 of the Ringelmann Smoke Chart.

(c) The provisions of Section 3.2(b) shall not apply to smoke emitted during the building of a new fire, the shade or appearance of which is not greater than No. 2 of the Ringelmann Smoke Chart for a period of three consecutive minutes; or emissions of such opacity within a stack or chimney, or exclusive of water vapor, of such opacity leaving a stack or chimney to a degree greater than the emission designated as No. 2 of the Ringelmann Smoke Chart for a period greater than three consecutive minutes.

3.3 UNBURNED WASTE AND ASH

No person shall cause, suffer, allow, or permit the emission of particles of unburned waste or ash from any common incinerator or from any special incinerator which are individually large enough to be visible while suspended in the atmosphere.

3.4 ODORS

No person shall construct, install, use or cause to be used any common incinerator or any special incinerator which will result in odors being detectable by sense of smell in any area of human use or occupancy.

3.5 STACK TEST

(a) Any person responsible for the construction, installation, alteration, or use of an incinerator shall, when ordered by the Department, provide the facilities and necessary equipment for determining the density of smoke being discharged from a stack or chimney and shall conduct such smoke tests using methods approved by the Department. All smoke test data shall be recorded in a permanent log at such time intervals as specified by the Department. The data shall be maintained for a period of not less than one year and shall be available for review by the Department.

(b) Any person responsible for the use of a new or existing incinerator shall upon request of the Department provide such sampling facilities and testing facilities exclusive of instruments and sensing devices as may be necessary for the Department to determine the nature and quantity of emissions from such incinerators and shall, during such testing, operate the incinerator at a charging rate of waste no less than the designed capacity of the incinerator using materials representative of the types of wastes normally burned. Such facilities may be either permanent or temporary, at the discretion of the person responsible for their provision, and shall conform to all applicable laws and regulations concerning safe construction or safe practice.

## SECTION 4 – PERMIT TO CONSTRUCT AND CERTIFICATE TO OPERATE

4.1 No person shall construct or install any new incinerator, or any new control apparatus, or alter any existing incinerator, or any existing control apparatus without first having obtained a "Permit to Construct, Install or Alter Control Apparatus or Equipment" from the Department, in accordance with the provisions of Chapter IX of the New Jersey Air Pollution Control Code.

4.2 No person shall use or cause to be used any new or altered incinerator, or any new or altered control apparatus without first having obtained a "Certificate to Operate Control Apparatus or Equipment" from the Department, in accordance with the provisions of Chapter IX of the New Jersey Air Pollution Control Code.

## SECTION 5 – OPERATION

5.1 Written procedures to be followed for proper operation and maintenance of a new incinerator, or an altered existing incinerator, shall be submitted to the Department for review and approval together with the application for a certificate to operate.

5.2 Any person in possession of a "Certificate to Operate" an incinerator shall maintain said certificate readily available on the operating premises. Operating procedures and rated burning capacity of the incinerator shall be posted at a convenient place as near as practical to the point of operation.

5.3 No person shall use or cause to be used any incinerator unless all components connected, or attached to, or serving the incinerator, including control apparatus, are functioning properly and are in use, in accordance with the permit to construct, and the certificate to operate.

## SECTION 6 – EXCEPTIONS

6.1 The provisions of this Chapter shall not apply to incinerators installed or used in one or two family dwellings or in multi-occupied dwellings containing six or less family units one of which is owner occupied.

# NEW JERSEY STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION
# NEW JERSEY AIR POLLUTION CONTROL CODE

# CHAPTER 12
# PREVENTION AND CONTROL OF AIR POLLUTION EMERGENCIES

**Original Effective Date: October 24, 1969**
**Revised Version Promulgated: January 27, 1972**
**To be Effective: March 27, 1972**

Chapter 12 – PREVENTION AND CONTROL OF AIR POLLUTION EMERGENCIES, which became effective October 24, 1969, is hereby repealed. This repeal shall not affect actions, proceedings, or departmental orders pending or outstanding on the effective date of the new regulation; said actions, proceedings, or departmental orders may be prosecuted, defended and continued in the same manner and to the same effect as if the new regulation had not been adopted. The text of the new regulation follows:

## Section 1 – Definitions

The following terms as used in this Chapter shall mean and include:

1.1 AIR CONTAMINANT: Solid particles, liquid particles, vapors or gases which are discharged into the outdoor atmosphere.

1.2 PRIMARY METALS INDUSTRIES: Establishments engaged in the smelting, refining, sintering and alloying of ferrous and non-ferrous metals from ore, pig or scrap, and the manufacture of castings, forgings, powdered metals and other basic products of ferrous or non-ferrous metals, including the production of coke.

1.3 PETROLEUM REFINING AND RELATED INDUSTRIES: Establishments engaged in petroleum refining, the manufacture of paving and roofing materials from petroleum products and compounding paving and building materials from petroleum products.

1.4 CHEMICAL AND ALLIED PRODUCTS INDUSTRIES: Establishments engaged in the manufacture of (1) basic chemicals such as acids, alkalies, salts, industrial gases and organic chemicals, (2) chemical products to be used in further manufacturing such as synthetic fibers, plastics, dry colors and pigments, (3) finished chemical products to be used for ultimate consumption such as drugs, cosmetics, soap, paints, fertilizers and explosives.

1.5 PAPER AND ALLIED PRODUCTS INDUSTRIES: Establishments engaged in manufacturing wood pulp from wood or other materials and the manufacture of paper, paperboard and building papers.

1.6 GLASS, CLAY AND CONCRETE PRODUCTS INDUSTRIES: Establishments engaged in the manufacture of glass, glassware, textile fibers, glass insulation wool, structural clay products, concrete products, gypsum and plaster products, lime, abrasives and asbestos.

## Section 2 – Emergency Criteria

A condition justifying proclamation by the Governor of an AIR POLLUTION ALERT, AIR POLLUTION WARNING, or AIR POLLUTION EMERGENCY shall be deemed to exist whenever the Commissioner determines that the accumulation of air contaminants in any place, locality, county or other area in the state is attaining or has attained levels which could, if such levels are sustained or exceeded, lead to a threat to the health of the public. Such determinations shall be in accordance with criteria published in the New Jersey Register and on file with the Department.

## Section 3 – Criterion for Emergency Termination

In making a determination that the threat resulting from the accumulation of air contaminants no longer exists, the Commissioner shall be guided by measurements of air quality and advisories provided by the United States Weather Service.

## Section 4 – Standby Plans

4.1 Any person responsible for the operation of a source of air contamination as set forth in Table I of this Section shall prepare standby plans, consistent with good industrial practice and safe operating procedures, for reducing the

emission of air contaminants into the outdoor atmosphere during periods of an AIR POLLUTION ALERT, AIR POLLUTION WARNING, and AIR POLLUTION EMERGENCY. Standby plans shall be designed to reduce or eliminate emissions of air contaminants into the outdoor atmosphere in accordance with the objectives set forth in Tables I-III which are made a part of this Section.

4.2 Any person responsible for the operation of a source of air contamination not set forth under Section 4.1 shall, when requested by the Department in writing, prepare standby plans, consistent with good industrial practice and safe operating procedures, for reducing the emission of air contaminants into the outdoor atmosphere during periods of an AIR POLLUTION ALERT, AIR POLLUTION WARNING, and AIR POLLUTION EMERGENCY. Standby plans shall be designed to reduce or eliminate emissions of air contaminants into the outdoor atmosphere in accordance with the objectives set forth in Tables I-III.

4.3 Standby plans as required under Sections 4.1 and 4.2 shall be in writing and show the source of air contamination, the approximate amount of reduction of contaminants and a brief description of the manner in which the reduction will be achieved during an AIR POLLUTION ALERT, AIR POLLUTION WARNING, and AIR POLLUTION EMERGENCY.

4.4 During a condition of AIR POLLUTION ALERT, AIR POLLUTION WARNING, and AIR POLLUTION EMERGENCY, standby plans as required by this Section shall be made available on the premises to any person authorized to enforce the provisions of the Air Pollution Emergency Control Act.

4.5 Standby plans as required by this section shall be submitted to the Department upon request within thirty days of the receipt of such request; such standby plans shall be subject to review and approval by the Department. If, in the opinion of the Department, such standby plans do not effectively carry out the objectives as set forth in Tables I-III, the Department may disapprove said standby plans, state its reason for disapproval and order the preparation of amended standby plans within the time period specified in the order. Any person aggrieved by the order requiring the preparation of a revised plan is entitled to a hearing in accordance with C.26:2C-14.1 of the Air Pollution Control Act. If the person responsible fails within the time period specified in the order to submit an amended standby plan which in the opinion of the Department meets the said objectives, the Department may revise the standby plan to cause it to meet these objectives. Such revised plan will thereafter be the standby plan which the person responsible will put into effect upon the issuance of an appropriate order by the Governor.

## TABLE I – EMISSION REDUCTION OBJECTIVES

| Source of Air Contamination | Air Pollution Alert |
|---|---|
| 1. Coal or oil-fired electric power generating facilities. | a. Substantial reduction by utilization of fuels having lowest available ash and sulfur content.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Substantial reduction by diverting electric power generation to facilities outside of Alert Area. |
| 2. Coal or oil-fired process steam generating facilities having a capacity to burn in excess of four tons of coal per hour or 600 gallons of fuel oil per hour. | a. Substantial reduction by utilization of fuels having lowest available ash and sulfur content.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Reduction of steam load demands consistent with continuing plant operations. |
| 3. A. Manufacturing industries of the following classifications which employ more than twenty (20) employees at any one location:<br>Primary Metals Industries<br>Petroleum Refining and Related Industries<br>Chemical and Allied Products Industries<br>Paper and Allied Products Industries<br>Glass, Clay and Concrete Products Industries<br>AND<br>B. Other persons required by the Department to prepare standby plans. | a. Substantial reduction of air contaminants from manufacturing operations by curtailing, postponing, or deferring production and allied operations.<br>b. Maximum reduction by deferring trade waste disposal operations which emit particles, gases, vapors or malodorous substances.<br>c. Reduction of heat load demands for processing consistent with continuing plant operations.<br>d. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing or soot blowing. |
| 4. Municipal and commercial refuse disposal operations. | a. Maximum reduction by prevention of open burning on all refuse disposal areas.<br>b. Substantial reduction by limiting burning of refuse in incinerators to the hours between 12:00 Noon and 4:00 p.m. |

## TABLE II — EMISSION REDUCTION OBJECTIVES

| Source of Air Contamination | Air Pollution Warning |
|---|---|
| 1. Coal or oil-fired electric power generating facilities. | a. Maximum reduction by utilization of fuels having lowest available ash and sulfur content.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Maximum reduction by diverting electric power generation to facilities outside of Warning Area. |
| 2. Coal or oil-fired process steam generating facilities having a capacity to burn in excess of four tons of coal per hour or 600 gallons of fuel oil per hour. | a. Maximum reduction by utilization of fuels having the lowest available ash and sulfur content.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Reduction of steam load demands consistent with continuing plant operations.<br>d. Making ready for use a plan of action to be taken if an emergency develops. |
| 3. A. Manufacturing industries of the following classifications which employ more than twenty (20) employees at any one location:<br>Primary Metals Industries<br>Petroleum Refining and Related Industries<br>Chemical and Allied Products Industries<br>Paper and Allied Products Industries<br>Glass, Clay and Concrete Products Industries<br>AND<br>B. Other persons required by the Department to prepare standby plans. | a. Maximum reduction of air contaminants from manufacturing operations by, if necessary, assuming reasonable economic hardship by postponing production and allied operations.<br>b. Maximum reduction by deferring trade waste disposal operations which emit particles, gases, vapors or malodorous substances.<br>c. Reduction of heat load demands for processing consistent with continuing plant operations.<br>d. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing or soot blowing. |
| 4. Municipal and commercial refuse disposal operations. | a. Maximum reduction by prevention of open burning on all refuse disposal areas.<br>b. Complete elimination of the use of incinerators. |

## TABLE III -- EMISSION REDUCTION OBJECTIVES

| Source of Air Contamination | Air Pollution Emergency |
|---|---|
| 1. Coal or oil-fired electric power generating facilities. | a. Maximum reduction by utilization of fuels having lowest available ash and sulfur content.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Maximum reduction by diverting electric power generation to facilities outside of Emergency Area. |
| 2. Coal or oil -fired process steam generating facilities having a capacity to burn in excess of four tons of coal per hour or 600 gallons of fuel oil per hour. | a. Maximum reduction by reducing heat and steam demands to absolute necessities consistent with preventing equipment damage.<br>b. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing and soot blowing.<br>c. Taking the action called for in the emergency plan. |
| 3. A. Manufacturing industries of the following classifications which employ more than twenty (20) employees at any one location:<br>Primary Metals Industries<br>Petroleum Refining & Related Industries<br>Chemical and Allied Products Industries<br>Paper and Allied Products Industries<br>Glass, Clay and Concrete Products Industries<br>AND<br>B. Other persons required by the Department to prepare standby plans. | a. Elimination of air contaminants from manufacturing operations by ceasing, curtailing, postponing or deferring production and allied operations to the extent possible without causing injury to persons or damage to equipment.<br>b. Elimination of air contaminants from trade waste disposal processes which emit particles, gases, vapors or malodorous substances.<br>c. Maximum reduction of heat load demands for processing.<br>d. Maximum utilization of mid-day (12:00 Noon to 4:00 p.m.) atmospheric turbulence for boiler lancing or soot blowing. |
| 4. Municipal and commercial refuse disposal operations. | a. Maximum reduction by prevention of open burning on all refuse disposal areas.<br>b. Complete elimination of the use of incinerators. |

## Section 5 -- Standby Orders

Following are standby orders which might be appropriate for use by the Governor upon his declaration that an Air Pollution Emergency exists:

5.1 Air Pollution Alert:

a. Any person responsible for the operation of a source of air contamination as set forth in Table I of Section 4 shall take all AIR POLLUTION ALERT actions as required for such source of air contamination; and shall particularly put into effect the standby plans for an AIR POLLUTION ALERT.

b. There shall be no open burning by any persons of tree waste, vegetation, refuse, or debris in any form.

c. The use of incinerators for the disposal of any form of solid waste shall be limited to the hours between 12:00 Noon and 4:00 p.m.

d. Persons operating fuel-burning equipment which requires boiler lancing or soot blowing shall perform such operations only between the hours of 12:00 Noon and 4:00 p.m.

5.2 Air Pollution Warning:

a. Any person responsible for the operation of a source of air contamination as set forth in Table II of Section 4 shall take all AIR POLLUTION WARNING actions as required for such source of air contamination; and shall particularly put into effect the standby plans for an AIR POLLUTION WARNING.

b. There shall be no open burning by any persons of tree waste, vegetation, refuse or debris in any form.

c. The use of incinerators for the disposal of any form of solid waste or liquid waste shall be prohibited.

d. Persons operating fuel-burning equipment which requires boiler lancing or soot blowing shall perform such operations only between the hours of 12:00 Noon and 4:00 p.m.

5.3 Air Pollution Emergency:

a. Any person responsible for the operation of a source of air contamination as described in Table III of Section 4 shall take all AIR POLLUTION EMERGENCY actions as listed as required for such source of air contamination; and shall particularly put into effect the standby plans for an AIR POLLUTION EMERGENCY.

b. All manufacturing establishments except those included in Section 5.3a will institute such action as will result in maximum reduction of air contaminants from their operations by ceasing, curtailing, or postponing operations which emit air contaminants to the extent possible without causing injury to persons or damage to equipment.

c. All places of employment described below shall immediately cease operations:

(1) Mining and quarrying of non-metallic minerals.

(2) All contract construction work except that which must proceed to avoid physical harm.

(3) Wholesale trade establishments, i.e. places of business primarily engaged in selling merchandise to retailers, to industrial, commercial, institutional or professional users, or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies.

(4) All offices of local, county, and state government including authorities, joint meetings, and any other public body; except to the extent that such offices must continue to operate in order to enforce the requirements of this order pursuant to statute.

(5) All retail trade establishments except pharmacies and stores primarily engaged in the sale of food.

(6) Banks; credit agencies other than banks; securities and commodities brokers, dealers, exchanges and services; offices of insurance carriers, agents and brokers; real estate offices.

(7) Wholesale and retail laundries; laundry services and cleaning and dyeing establishments; photographic studios; beauty shops, barber shops; shoe repair shops.

(8) Advertising offices; consumer credit reporting, adjustment and collection agencies; duplicating, addressing, blueprinting; photocopying, mailing, mailing list and stenographic services; equipment rental services; commercial testing laboratories.

(9) Automobile repair, automobile services, garages.

(10) Establishments rendering amusement and recreation services including motion picture theaters.

(11) Elementary and secondary schools, colleges, universities, professional schools, junior colleges, vocational schools, and public and private libraries.

d. There shall be no open burning by any person of tree waste, vegetation, refuse, or debris in any form.

e. The use of incinerators for the disposal of any form of solid or liquid waste shall be prohibited.

f. The use of motor vehicles is prohibited except in emergencies with the approval of local or state police.